RECYCLED WATER SUPPLIES

4.1 INTRODUCTION

This chapter identifies the Carlsbad Municipal Water District's (CMWD) supply and related storage needs required to meet the projected water demands identified in Chapter 3. This chapter starts with a description of the existing and future recycled water supply sources. Subsequently, the capacity of these sources are compared with the projected recycled water demands to determine any supply shortfalls. As part of the supply evaluation, six supply scenarios are evaluated based on various combinations of expanding supply sources. This chapter is concluded with a supply strategy that describes the phasing of supply projects to accommodate the recommended system configuration described in Chapter 9 of this recycled water master plan (RWMP).

4.2 SUPPLY SOURCES

This section discusses each of CMWD's existing recycled water supply sources and their associated capacities as well as the historical utilization of each supply source.

4.2.1 Existing Supply Sources

As discussed in Chapter 3, CMWD receives recycled water from three reclamation plants: Carlsbad Water Recycling Facility (WRF), Meadowlark WRF, and Gafner Water Reclamation Plant (WRP).

The **Carlsbad WRF** is owned by CMWD; and the Encina Wastewater Authority (EWA) has been contracted to provide operation and maintenance through a memorandum of understanding (MOU) dated May 1, 2005.

The **Meadowlark WRF** is owned and operated by the Vallecitos Water District and serves both CMWD's recycled water system and a portion of the Olivenhain Municipal Water District's (OMWD) recycled water system within the City of Carlsbad.

The **Gafner WRP** is owned and operated by the Leucadia Wastewater District and serves only the south golf course of the La Costa Resort. The Gafner WRP does not connect to the rest of CMWD's recycled water distribution system.

Carlsbad WRF and Gafner WRP currently operate as tertiary treatment plants, treating secondary effluent from the Encina Water Pollution Control Facility (EWPCF). Meadowlark WRF operates as a "skimming" plant, discharging solids into a 10-inch diameter sludge pipeline for treatment at the EWPCF. The capacities of the Carlsbad WRF, Meadowlark WRF, and Gafner WRP are presented in Table 4.1 along with CMWD's recycled water allocation.

Table 4.1 Recycled Water Supplies
Recycled Water Master Plan
Carlsbad Municipal Water District

Reclamation Plant Name	Owner	Permitted Capacity(1) (mgd)	Maximum CMWD Allocation (mgd)	Other Allocations (mgd)
CWRF	CMWD	4.0	4.00	0.0
MWRF	VWD	5.0	3.00(2)	1.5(3)
GWRP	LWWD	1.0	0.75(4)	0.0
Total Capacity		**10.0**	**7.75**	**1.5**
Total Usable Capacity(5)			**7.60(5)**	

Notes:
VWD = Vallecitos Water District; LWWD = Leucadia Wastewater District
(1) Maximum discharge flow as stated in permit (CWRF Order No. 2001-0352; MWRF Order No. R9-2007-0018; GWRP Order No. R9-2004-0223, included in Appendix E).
(2) Rated capacity of MWRF is 5.0 mgd. However, discussions with VWD staff have indicated that the WRF historically has produced less flow than rated. While the rated capacity is 5.0 mgd, the actual produced flow is less (3.2 mgd in 2009) due to insufficient wastewater flow to Meadowlark. CMWD's agreement with VWD limits supply availability to 3.0 mgd during summer months and 2.0 mgd during winter months.
(3) Current MWRF allocation for the Olivenhain Municipal Water District is 1.0 mgd with an option to purchase up to 1.5 mgd.
(4) Based on the agreement between LWWD and CMWD (included in Appendix D) that states that the GWRP can produce up to 0.75 mgd, a maximum and minimum annual purchase of 840 afy (0.75 mgd) and 394 afy (0.35 mgd), respectively.
(5) As the GWRP is not connected to CMWD's recycled water system and the demand of the La Costa Resort and Spa south golf course MMD is only 0.6 mgd (versus 0.75 mgd capacity at GWRP), the total existing usable capacity is limited to 7.6 mgd.

As shown in Table 4.1, CMWD currently has 7.75 mgd of allocated supply capacity, although only 7 mgd is available to CMWD's primary recycled water distribution system as Gafner WRP only supplies the La Costa Resort and Spa south golf course and is not connected to the rest of the distribution system. In total, the reclamation plants have a permitted capacity of 10 mgd.

4.2.2 Historical Supply Utilization

While daily supply data for Meadowlark WRF and Carlsbad WRF was available (EJPA, 2009) for January 2005 through June 2009, the daily demands for the OMWD system were not known for the same period, and thus could not be deducted to determine CMWD's daily utilization of supply sources. Monthly supply data for the portion of flow supplied to CMWD's distribution system by Meadowlark WRF, as well as total flow from Carlsbad WRF, and Gafner WRP was available (CMWD, 2011) for the calendar year 2010 and is presented in Table 4.2.

During periods of high recycled water demands or recycled water supply outages, CMWD has had to supplement its recycled water system with potable water. Potable water can be introduced to the recycled water distribution at CMWD's D Tanks, through the use of an air gap. The connection is made up of a meter and an 8-inch diameter Pressure Sustaining

Valve (PSV), which, according to CMWD staff, can convey at least 3,000 gpm. Potable water can also be supplemented in the system feeding the La Costa Resort and Spa south golf course from Gafner WRP. In addition, VWD has a potable water connection at Mahr Reservoir, which can be used to supplement recycled water in the reservoir with potable water through an air gap.

Table 4.2 Utilization of Recycled Water Supplies
Recycled Water Master Plan
Carlsbad Municipal Water District

Source	Average Annual Supply in 2010 (afy)	Average Annual Supply in 2010 (mgd)	Percentage of Average Annual Supply in 2010	Maximum Month Supply[(2)] in 2010 (mgd)	Percentage of Maximum Month Supply in 2010 (mgd)
CWRF	969	0.9	28%	2.2	38%
MWRF [(1)]	2,272	2.0	66%	2.9	50%
GWRP	195	0.2	5%	0.6	11%
Potable Water [(3)]	30	< 0.1	1%	0.1	1%
Total	**3,466**	**3.1**	**100%**	**5.8**	**100%**

Notes:
(1) Portion of MWRF recycled water supplied to CMWD. MWRF also supplies recycled water to OMWD customers.
(2) The month of maximum demand in calendar year 2010 was 5.8 mgd in June 2010. Note that maximum month supply for individual sources varied by supply source (e.g., MWRF produced its maximum monthly flow in May 2010).
(3) Potable makeup water use in 2010 included 4.8 afy at the D Tank supplemental water connection and 25.7 afy at Gafner WRP.

As shown in Table 4.2, in 2010, CMWD obtained the greatest percentage of its supply from the Meadowlark WRF. Under typical operations, CMWD first obtains supply from the Meadowlark WRF and uses the Carlsbad WRF to balance supply with demand because CMWD pays for allocated supplies from Meadowlark WRF even if the supply is not used. In accordance with the inter-agency agreement, CMWD purchases 2 mgd from December through March (4 months) and 3 mgd from April through November (8 months). Note that in 2009, CMWD obtained the largest component of its supplies from Carlsbad WRF because the Meadowlark WRF has at times not provided the contracted 3 mgd due to a lack of influent flow that limited effluent recycled water production. Influent flow at the Meadowlark WRF did not match expected flow projections from the time of the Meadowlark WRF expansion because the housing downturn had slowed development, which would have increased influent flow.

During the maximum month (June 2010) CMWD's demand was 5.8 mgd. During this month, CMWD still obtained the majority of its flow from Meadowlark WRF, with slightly more supply coming from Carlsbad WRF. It should be noted that potable makeup water was primarily supplemented at Gafner WRP when Gafner WRP was offline for several months in 2010. Potable makeup water at the Twin D tanks was primarily used in

June 2010 when demands were the highest of the year. Note that data for VWD's potable water makeup connection at Mahr Reservoir was not available and is not included in Table 4.2.

During the minimum month (February 2010), CMWD's demands were only 0.51 mgd, significantly less than the 2.0 mgd allocation from Meadowlark WRF. CMWD supplied demands during this month almost exclusively from Meadowlark WRF.

Daily flows from Carlsbad WRF and Meadowlark WRF were obtained from water quality reports to the regional water quality control board (EJPA, 2009) for January 2005 through June 2009. As discussed in Chapter 3, it was assumed that MDD will be similar to MMD since CMWD's customers are primarily irrigation in nature. While daily flow data was analyzed to determine the actual MDD to MMD ratio, several limitations were found in the daily flow data. Limitations precluding this calculation included daily effluent data for Meadowlark WRF was reported for total plant flow including OMWD's demands, daily flows for potable makeup water were not reported, several daily flows from Carlsbad RWMP significantly exceeded the rated capacity, daily storage in Mahr Reservoir was not reported.

Figure 4.1 presents the total annual historical supply for calendar years 2002 through 2010, including potable makeup water. Note that data for 2004 was not available, and supply data for 2009 was only available through June 2009 due to the fiscal year (supply data was projected for the rest of the year). Average annual demand data from billing records is overlaid on Figure 4.1 for the calendar years 2004 through 2010. As shown, the demand reported in 2010 slightly exceeded reported supplies, likely due to rounding in monthly reporting.

As shown in Figure 4.1, demand increased significantly between 2003 and 2005 as Phase II customers began to be connected.

Figure 4.2 shows approximate historical supply for each supply source. Supplies for Meadowlark WRF and Gafner WRP were taken from the annual reports for the Reclaimed Water Development Fund (CMWD, 2011), while supply data for Carlsbad WRF were taken from daily flow monitoring from monthly water quality monitoring reports obtained from Encina Joint Powers Authority (EJPA, 2009). Since the annual reports for the Reclaimed Water Development Fund are summarized by fiscal year, and reports specific to each supply source for some consecutive years were not available, supply for the months available was assumed to be representative of the full calendar year.

As shown in Figure 4.2, total recycled water supply to CMWD increased between 2006 and 2008 due to the addition of the Carlsbad WRF in 2006 and the completion of upgrades to the Meadowlark WRF in 2008. Overall supplies decreased in 2010 in response to the decreased demands discussed in Chapter 3.

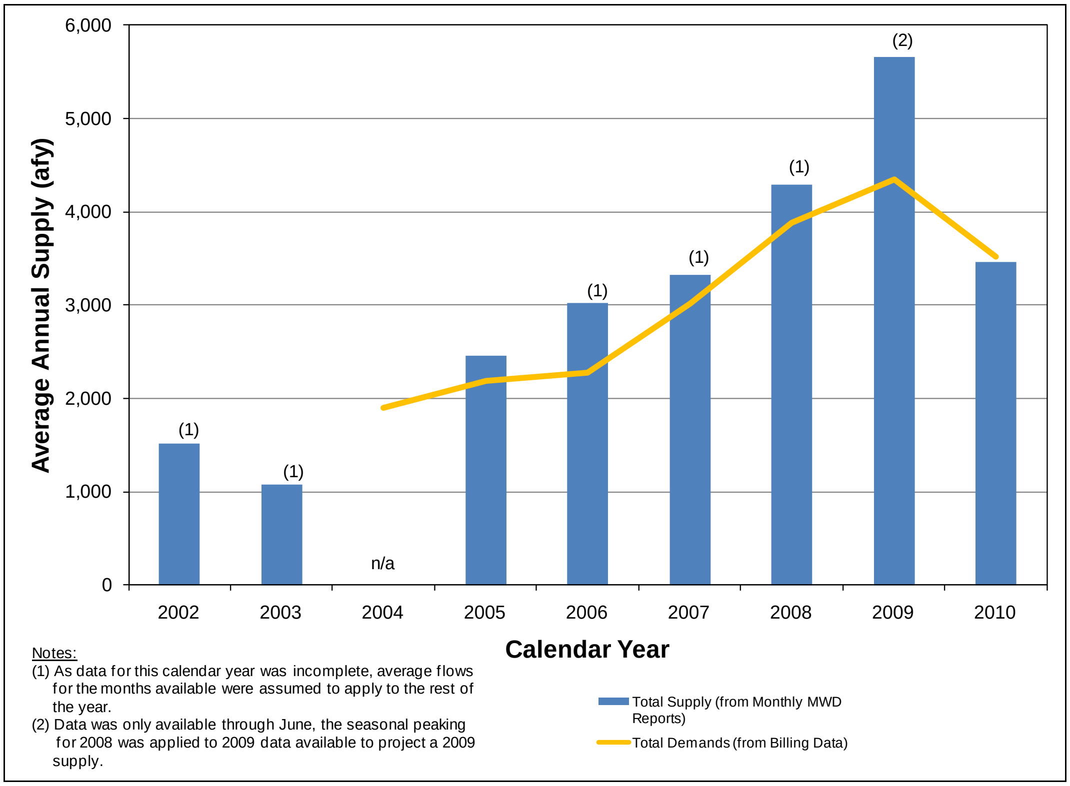


Figure 4.1 Historical Supply

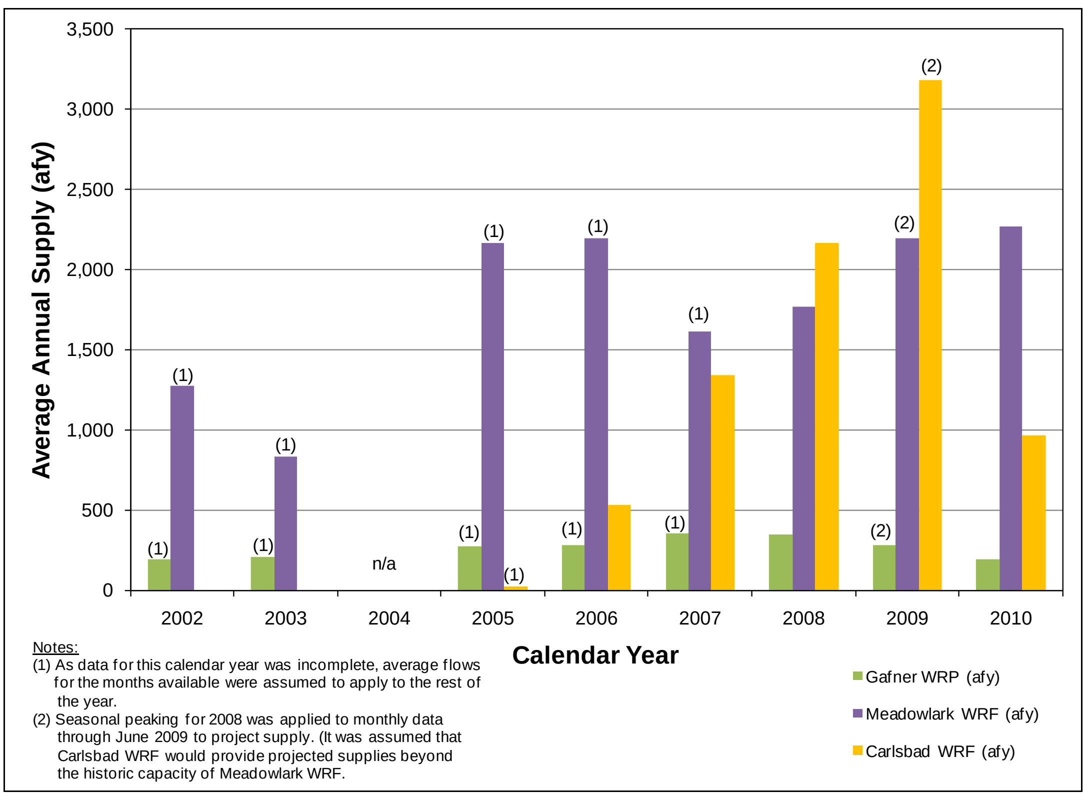


Figure 4.2 Historical Supply by Source

4.2.3 Water Quality of Existing Supply Sources

Water quality from the existing sources was analyzed to determine any restrictions that may exist for irrigation uses. Water quality data was tabulated and compared to existing guidelines for irrigation use restrictions. This data is summarized in Table 4.3.

As shown in Table 4.3, the average historical water quality samples do not indicate any severe restrictions for any of CMWD's recycled water supply sources. As there are no parameters that fall in the severe restriction category, CMWD should be able to use their existing recycled water sources for its irrigation demands with proper quality management.

However, due to some water quality parameters, the use of recycled water may not be suitable for some sensitive plant species. For instance, discussions between CMWD staff and specific agricultural users have indicated concerns about water quality parameters which may affect required treatment, including boron, manganese, and TDS.

Boron

One constituent of potential concern is boron. Currently, effluent from all three wastewater reclamation plants contains a boron concentration of approximately 0.4 mg/L, as displayed in Table 4.3. In the future, this effluent concentration could increase due to the construction of the new Poseidon desalination facility in the City of Carlsbad (City).

The new desalination facility will use reverse osmosis treatment to desalt ocean water for drinking water purposes. Typical ocean water has a boron concentration between 4 and 5 mg/L. According to correspondence with the City, the new plant's effluent will have a boron concentration of approximately 0.75 mg/L. Once this new supply is integrated with Carlsbad's existing potable water supply, the concentration of boron will increase. As a result, the concentration of boron in wastewater will also increase.

While, the increased concentration will not impact the "Degree of Use Restriction" in Table 4.3, the increased concentration in wastewater does have the potential of pushing treated recycled water effluent above the limit for boron as stated in CMWD's discharge permit. Currently, the permit stipulates a boron concentration limit of 0.75 mg/L for the Carlsbad WRF and 0.5 mg/L for the Meadowlark WRF.

It is recommended that CMWD coordinate with the new desalination plant to ensure that the boron concentration from the desalination plant will not cause recycled water effluent to exceed these permitted limits.

If the limit is exceeded, the only process capable of removing boron is reverse osmosis with upstream pH adjustment. At neutral pH, boron exists as boric acid (H_3BO_3), which is neutral and is a similar size to a molecule of water, allowing it to pass through RO membranes. Boron can be removed by raising the pH above 9, so the boron is deprotonated, forming dihydrogen borate (H_2BO_3-).

Table 4.3 Water Quality Guidelines for Irrigation Use
Recycled Water Master Plan
Carlsbad Municipal Water District

Water Quality Parameter[1]	Unit	Degree of Use Restriction[1,2,3,4] None	Slight to Moderate	Severe	Supply Source MWRF[7]	CWRF[8]	GWRP[9]
Salinity							
EC_w	dS/m	<0.7	**0.7-3.0**	>3.0	1.63	1.70	1.73
TDS	mg/L	<450	**450-2000**	>2000	991	965	1,076
Permeability[5]			EC_w = 0.9				
SAR = 0-3 and EC_w =		>0.7	0.7-0.2	<0.2			
SAR[6] = 3-6 and EC_w =		**>1.2**	1.2-0.3	<0.3	1.6	1.7	1.7
SAR = 6-12 and EC_w =		>1.9	1.9-0.5	<0.5			
SAR = 12-20 and EC_w =		>2.9	2.9-1.3	<1.3			
SAR = 20-40 and EC_w =		>5.0	5.0-2.9	<2.9			
Sodium (Na)							
Surface	SAR	<3	**3-9**	>9	4.0[6]	5.5[6]	5.6[6]
Sprinkler	mg/L	<70	**>70**		152	197	201
Chloride (Cl)							
Surface	mg/L	<140	**140-355**	>355	236	265	278
Sprinkler	mg/L	<100	**>100**		236	265	278
Boron (B)	mg/L	<0.7	**0.7-3.0**	>3.0	0.37	0.40	0.41
Bicarbonate	mg/L	<90	**90-500**	>500	192	219	225
pH	---		**6.5-8.4 (normal range)**		6.7	7.4	7.3
Nitrogen (N)							
Ammonia (NH_4)	mg/L		(see combined N values below)		N/A	N/A	N/A
Nitrate (NO_3)	mg/L		(see combined N values below)		N/A	N/A	N/A
Combined Nitrogen (N)	mg/L	<5	**5-30**	>30	N/A	N/A	16.1
Iron		Recommended maximum concentration of 5 mg/L. Not toxic to plants in aerated soils but can contribute to soil acidification and loss of reduced availability of essential phosphorus and molybdenum.					
Manganese		Recommended maximum concentration of 0.2 mg/L. Toxic to a number of crops at a few tenths to a few mg/L, but usually only in acid soils.					

Notes:
(1) Adapted from University of California Committee of Consultants (1974), and Ayers and Westcot (1994).
(2) Method and Timing of Irrigation: Assumes normal surface and sprinkler irrigation methods are used. Water is applied as needed, and the plants utilize a considerable portion of the available stored soil water (50% or more) before the next irrigation. At least 15 percent of the applied water percolates below the root zone (leaching fraction [LF] > 15%).
(3) Site Conditions: Assumes soil texture ranges from sandy loam to clay with good internal drainage with no uncontrolled shallow water table present.
(4) Bold text indicates where CMWD's Supply Sources from the right columns fall within the range shown. Definitions of "The Degree of Use Restriction" terms:
None = Recycled water can be used similar to the best available irrigation water.
Slight = Some additional management will be required above that with the best available irrigation water in terms of leaching salts from the root zone and/or choice of plants.
Moderate = Increased level of management required and choice of plants limited to those which are tolerant of the specific parameters.
Severe = Typically cannot be used due to limitations imposed by the specific parameters.
(5) Permeability is evaluated based on the combination of adjusted sodium adsorption ratio (SAR) and Electrical Conductivity (EC_w) values.
(6) Adjusted SAR (adj. RNa) includes the effect of bicarbonate/calcium ratio (Cax).
(7) Average of Samples from January 1998 through September 2009. Source: (EJPA, 2009).
(8) Average of Samples from November 2005 through September 2009. Source: (EJPA, 2009).
(9) Average of Quarterly Samples from Oct 2008 through September 2009 (TDS, N, Conductivity, and pH), Annual samples in June 2008 (Cl, B), and intermittent samples from 2002 through 2009 (Na, HCO3). Source: (EJPA, 2009).

For CMWD, removing boron would involve pH adjustment and installing a secondary RO treatment train at the Carlsbad WRF. As this addition adds additional capital cost to any plant expansion, it is recommended that CMWD control the concentration of boron at the source of potable water production, the new desalination plant.

Manganese

Another constituent of concern is manganese since CMWD's Carlsbad WRF exceeds the permitted effluent limit of 0.05 mg/L when the Carlsbad WRF is operated as designed. The Carlsbad WRF was designed for granular media filtration of 80 percent of the influent flow and MF/RO filtration for the remaining 20 percent of the influent flow. The flow streams are blended prior to distribution. As the Carlsbad WRF does not currently operate at capacity, there is spare MF/RO capacity. To reduce the manganese concentration, the plant operates beyond the 20/80 flow split, sending a greater percentage of flow to the MF/RO units. While, the MF/RO process reduces manganese, this solution is not permanent since the Carlsbad WRF will need to run at capacity in the future and will be restricted to the 20/80 flow split since spare MF/RO units will not be available.

Providing additional treatment for the removable of manganese will require improvements to the Carlsbad WRF, which requires a substantial investment for both facility improvements and operations. Removal of manganese typically involves the oxidation of the water soluble manganese ions (Mn^{+2}) with the addition of chlorine or potassium permanganate in a contact tank and the removal of the resulting insoluble manganese oxides through filtration. At the Carlsbad WRF, removal of manganese would involve a contact chamber for the addition of chlorine or potassium permanganate and possibly a new set of filters. The Carlsbad WRF could potentially use the existing granular media filters, but the effectiveness of the existing filters would need to be verified. It should be noted that the Carlsbad WRF also could replace the media of some existing filters with media designed specifically for manganese removal. Filtronics, Inc. has a proprietary media, FV03 Electromedia®, specially designed to remove manganese through magnetic attraction. Alternatively, manganese can be removed through a greensand process. The greensand process involves the use of filters with natural greensand zeolite that is coated with manganese oxides. The oxides on the greensand remove the soluble manganese ions until the oxides become saturated; at which point, the greensand oxides are regenerated with potassium permanganate. This alternative method does not involve a contact chamber, only greensand filters.

While manganese is an essential nutrient at low dosages, it is harmful to ingest at high doses. The EPA has set a Secondary Maximum Contaminant Level (SMCL) for manganese at 0.050 mg/L based on aesthetic concerns for drinking water such as staining and taste considerations. Ingestion of manganese through water consumption is not considered harmful unless the concentration is above 0.3 mg/L. The Regional Board most likely set the 0.05 mg/L limit in order to protect the underlying groundwater basins, which have manganese objectives of 0.05 mg/L. Manganese concentrations below 0.3 mg/L are not known to have any negative health effects beyond undesirable aesthetic qualities.

If possible, CMWD should attempt to ease the Regional Board's limits of manganese that are applicable to recycled water. In addition, the manganese concentration of water received from the MWD's Skinner plant is, on average, about 0.02 mg/L. This suggests that an industrial user in the City might be discharging manganese to the sewer. If possible, CMWD should also attempt to discern the source of manganese in the collection system. If the Regional Board does not ease the manganese limits, or if CMWD is unable to discern the source of the additional manganese, additional treatment at the Carlsbad WRF plant will be required since running the spare reverse osmosis units for manganese removal is an expensive method for manganese removal. For the purposes of this study, it is assumed that additional MF/RO capacity will not be required when the Carlsbad WRF is expanded in the future.

Total Dissolved Solids (TDS)

As discussed previously, Carlsbad WRF was designed for granular media filtration of 80 percent of the influent flow and MF/RO filtration for the remaining 20 percent of the influent flow. The MF/RO treatment was included to reduce TDS levels in the secondary effluent from the Encina Water Pollution Control Facility (EWPCF). The 1997 RWMP describes TDS levels ranging above 1,300 mg/L. In discussions with CMWD staff, it was learned that after the Carlsbad WRF came online, an investigation was conducted to determine the source of the high TDS levels. This investigation identified a specific user discharging seawater into the sewer system. Once this discharge was discontinued, the TDS levels in EWPCF's secondary effluent were reduced. Based on the lowered TDS levels, it is assumed that future expansions of Carlsbad WRF will not require additional MF/RO capacity.

4.2.4 Supply from Seasonal Storage

Since CMWD's demands are primarily landscape irrigation in nature, peak demands occur seasonally. Seasonal storage can be used to buffer the peak seasonal flows when the daily demands exceed the supply capacity of the supply sources in lieu of expanding plant capacity. In order to use seasonal storage as a supply, excess supply in months of low seasonal demand must be placed into seasonal storage to be pulled out in months where demand exceeds supply capacity. One of the key challenges with seasonal storage as a source of supply is to limit utilization of seasonal storage supplies before the peak months. Otherwise, supply shortages may occur.

A sample supply strategy for supply planning with seasonal storage is presented in Figure 4.3. Based on the usable existing supply capacity of 7.6 mgd (see Table 4.1) and a seasonal storage capacity of 32 MG (CMWD's allocation capacity in Mahr Reservoir), CMWD could meet an average annual demand of 4.9 mgd based on the current seasonal peaking behavior of CMWD's customer. This corresponds to a maximum month demand of 8.3 mgd using a peaking factor of 1.7 (see Table 3.5).

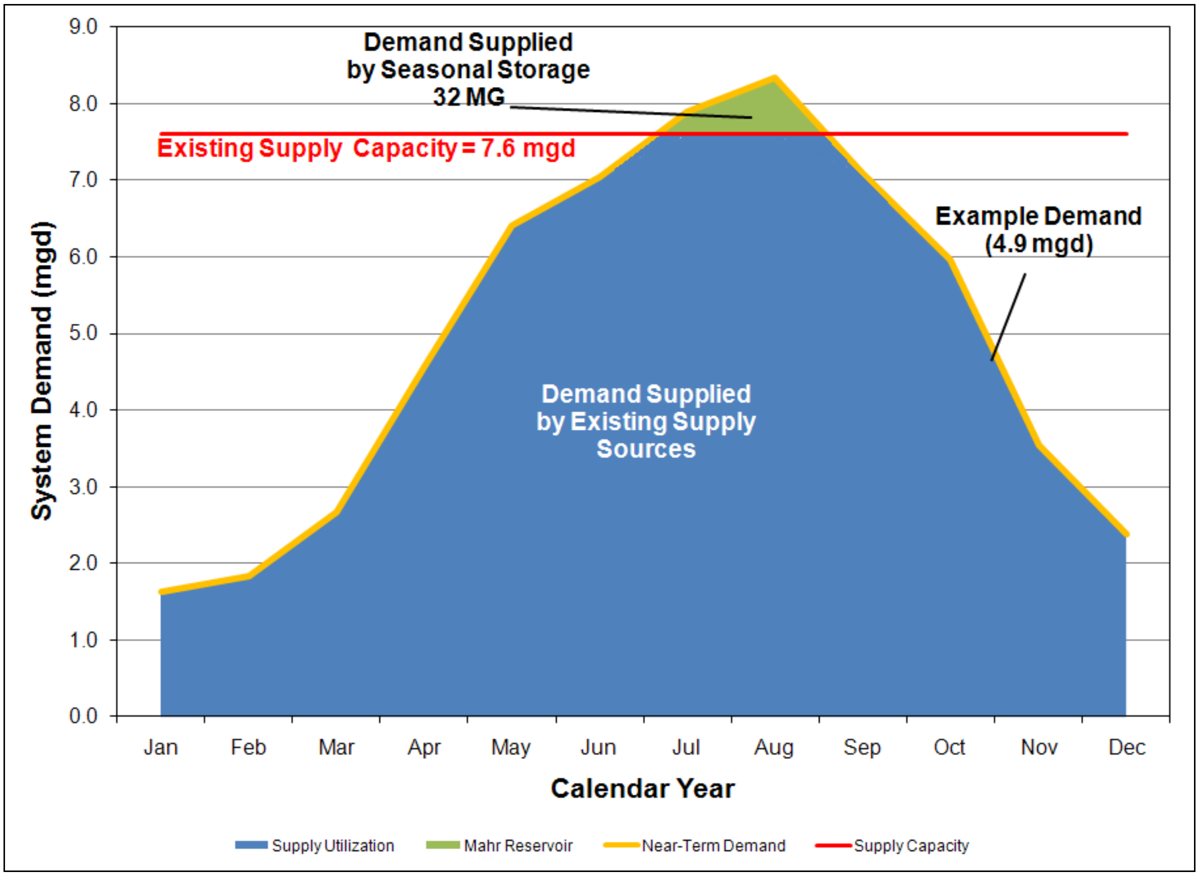


Figure 4.3 Seasonal Storage Requirement

Hence, the existing seasonal storage capacity would be sufficient to provide about 0.7 mgd of supply during summer months. Assuming that the 32 MG is available, this corresponds to 45 days of 1.5 months.

Currently, CMWD has adequate supply capacity such that seasonal storage is not necessary. However, as CMWD's peak summer demands grow, taking advantage of seasonal storage can delay treatment plant upgrades. In addition, it should be noted that Mahr Reservoir historically has experienced the following issues:

- Water quality issues related to algae growth.
- Low reservoir levels related to insufficient flows from Meadowlark WRF.

These issues are interrelated as low water levels result in higher water temperatures, which then causes more algae growth. As Mahr Reservoir is located south from the Meadowlark WRF, the majority of reservoir outflow goes to OMWD's system, while CMWD receives treated water from Meadowlark WRF. When Meadowlark WRF produces more than CMWD's demand, the remaining flow is directed to Mahr Reservoir. Due to this system configuration, OMWD receives more water from Mahr Reservoir than CMWD and experiences the related water quality issues. OMWD is therefore interested in reducing its take from Mahr Reservoir and obtaining recycled water from the Carlsbad WRF through a new pipeline connection along El Camino Real. As this new connection enters OMWD's system in the lower zones, the higher zones that are currently fed from Mahr Reservoir can only be served if additional pumping stations and east-west pipelines are constructed to connect the lower and higher pressure zones in OMWD's recycled water system. As this expansion of OMWD's system is not likely to happen in the near future, it is assumed that OMWD will maintain its current take from Meadowlark WRF and its 18 MG share in Mahr Reservoir. For planning purposes, it is therefore assumed that CMWD's seasonal storage capacity in Mahr Reservoir remains 32 MG.

4.2.5 Potential Future Supply Sources

CMWD is approaching a supply shortfall once the future demands are realized. There are various options to address this shortfall and expand the recycled water supply capacity. These options are discussed below and include:

- Expansion of Carlsbad WRF
- Increased allotment from Meadowlark WRF to CMWD
- Increased supply from Gafner WRP by connecting Gafner WRP to CMWD's recycled water system via a pump station and pipelines
- Re-activation and connection to Shadowridge WRF
- Surface water treatment plant for stormwater runoff into Lake Calavera

An expansion of Carlsbad WRF could be one potential source of additional supply. According to the 2001 Influent Pumping and Equalization Preliminary Design Report (MWH, 2001), the ultimate design capacity of the Carlsbad WRF is 16 mgd. While the report only quantifies the necessary changes required to the pumping system to accommodate the additional capacity, it is assumed that the rest of the facility is designed such that it can also accommodate the treatment expansions to reach the ultimate capacity of 16 mgd.

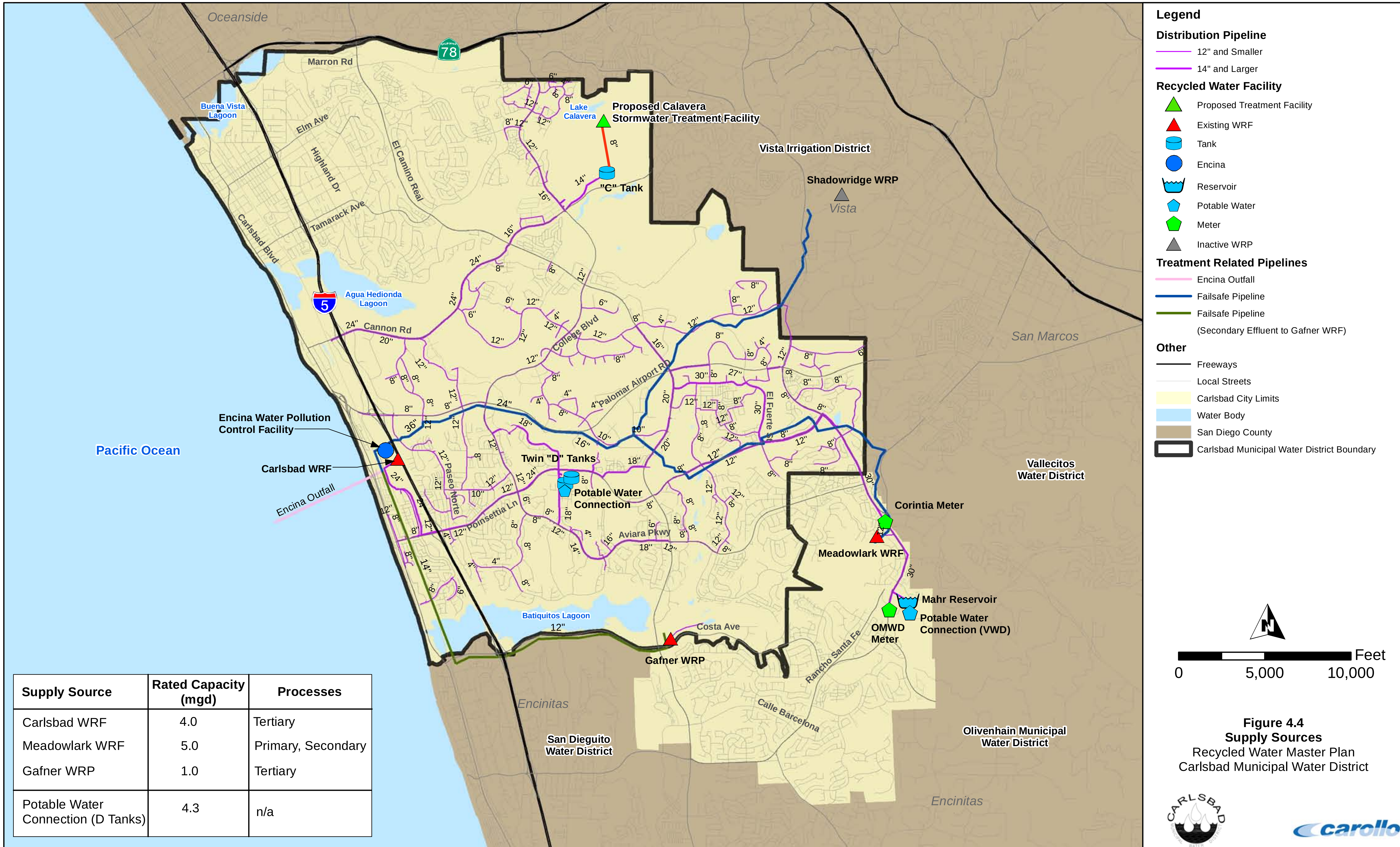
A second alternative could be securing additional supply from Meadowlark WRF. Since the historic limitation to supply from Meadowlark WRF has been low influent wastewater flows, this would most likely need to consist of obtaining some of OMWD's allocation in exchange for supplying some of OMWD's lower zone demand from CMWD's system. Based on discussions with CMWD staff, it is anticipated that influent wastewater flows to Meadowlark WRF will not exceed 4 mgd, resulting in a maximum supply of about 3.5 mgd.

A third source of additional supply could be connection of the Gafner WRP to the rest of CMWD's recycled water system. As discussed previously, CMWD's current utilization of Gafner WRP is less than its rated capacity. It is possible that the remaining capacity could be used within the rest of CMWD's recycled water system or expansion could increase potential supply from Gafner WRP. A technical memorandum completed for Leucadia Wastewater District (LWWD) in October 2010 indicated an expansion of up to 3.7 mgd would cost approximately $35.8 million.

In addition, the Shadowridge WRP, owned by the Buena Sanitation District (BSD), is currently not in service. However, a study dated September 2010 by PBS&J for the City of Vista evaluated reactivation of the plant. Three alternatives were analyzed, and a 2-mgd MBR process was noted as "may be cost-effective". If reactivated, 1 mgd of effluent would be allocated to the adjacent Shadowridge Golf Course, park, and high school, while the remaining 1 mgd could be available to CMWD. However, the analysis assumed that CMWD would need to accept the full flow of the facility throughout the year, less than used by the Shadowridge Golf Course. Similar to Meadowlark WRF, Shadowridge WRP is intended to operate as a "skimming" plant, discharging solids into a solids discharge pipeline, which is also referred to as the failsafe pipeline. Solids are ultimately treated at the EWPCF. The locations of the Shadowridge WRP as well as the failsafe pipeline are shown on Figure 4.4.

The Lake Calavera supply option would divert water from Lake Calavera to a treatment site located at either the southwest or the southeast corner of Cannon Road and College Boulevard. Flow would be delivered to the treatment site via a new gravity line located in an existing sewer main easement. Based on similar treatment of surface water sources, treatment for Lake Calavera water would most likely consist of coagulation through a rapid mix tank and a flocculation tank, sedimentation, filtration, and chlorine addition. Depending on the measured water quality, the actual designed treatment process could change. If the water has both low turbidity and color (less than 25 units), Lake Calavera water treatment could consist of only direct filtration. For this study, the worst case (turbidity and color greater than 25 units) was assumed.

The locations of each of CMWD's existing facilities as well as the potential future supply sources are shown on Figure 4.4.



Supply Source	Rated Capacity (mgd)	Processes
Carlsbad WRF	4.0	Tertiary
Meadowlark WRF	5.0	Primary, Secondary
Gafner WRP	1.0	Tertiary
Potable Water Connection (D Tanks)	4.3	n/a

Figure 4.4
Supply Sources
Recycled Water Master Plan
Carlsbad Municipal Water District

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4.3 SUPPLY REQUIREMENTS

As described in Chapter 3, CMWD's existing system recycled water average annual demand is assumed as 4,000 acre-feet per year (afy) (3.6 mgd), with a corresponding maximum month demand of 6.1 mgd. The potential build out demand including demand for neighboring agencies is estimated at 9,106 afy (8.1 mgd) with a corresponding maximum month demand of 13.5 mgd. The general phasing of demands is presented in Table 4.4.

Table 4.4 Summary of Recycled Water Demands
Recycled Water Master Plan
Carlsbad Municipal Water District

Condition	Average Annual Demand (afy)	Average Day Demand (mgd)	Maximum Month Demand(1) (mgd)
Existing	4,000	3.6	6.1
Near-Term (Phases I and II)(2)	4,100	3.7	6.2
CMWD Build-out System(3)	**7,144**	**6.4**	**10.8**
Build-out System with Neighboring Agencies(4)	**9,106**	**8.1**	**13.5**

Notes:
(1) Assumes a Maximum Month Demand seasonal peaking factor (PF) based on individual customer peaking factors listed in customer database (see Appendix C).
(2) Includes 100 afy of Near Term / In Progress demands discussed in Chapter 3.
(3) Near-Term + Customer Database demands inside CMWD service area discussed in Chapter 3 less customers determined not feasible for connection in Chapter 9. Includes Areas of Potential Development discussed in Chapter 3.
(4) Near-Term + Customer Database demands discussed in Chapter 3 less customers determined not feasible for connection in Chapter 9. Includes Areas of Potential Development discussed in Chapter 3.

The projected water demands as listed in Table 4.4 and the existing supply allocation of 7.6 mgd during summer months are graphically depicted in Figure 4.5. As shown, the maximum month build-out demand associated with connection of all feasible customers within CMWD's service area, identified in Chapter 9, is 10.8 mgd. When compared with CMWD's existing supply allocation of 7.6 mgd, CMWD will need to find an additional 3.2 mgd of supply to serve CMWD's build-out system.

The MMD demand associated with connection of all feasible customers including those in neighboring agencies is 13.5 mgd. Hence, nearly 6 mgd of additional supply would be required to serve the build-out system including the demands identified outside CMWD's service area.

While CMWD has sufficient supply capacity for its Existing and Near-Term demands, it is anticipated that as future demands are added to CMWD's system as a part of Phase III, CMWD will need to develop new supply sources to expand its recycled water system. The required supply capacity to meet the projected MMD for each phase and the associated supply shortfalls are summarized in Table 4.5.

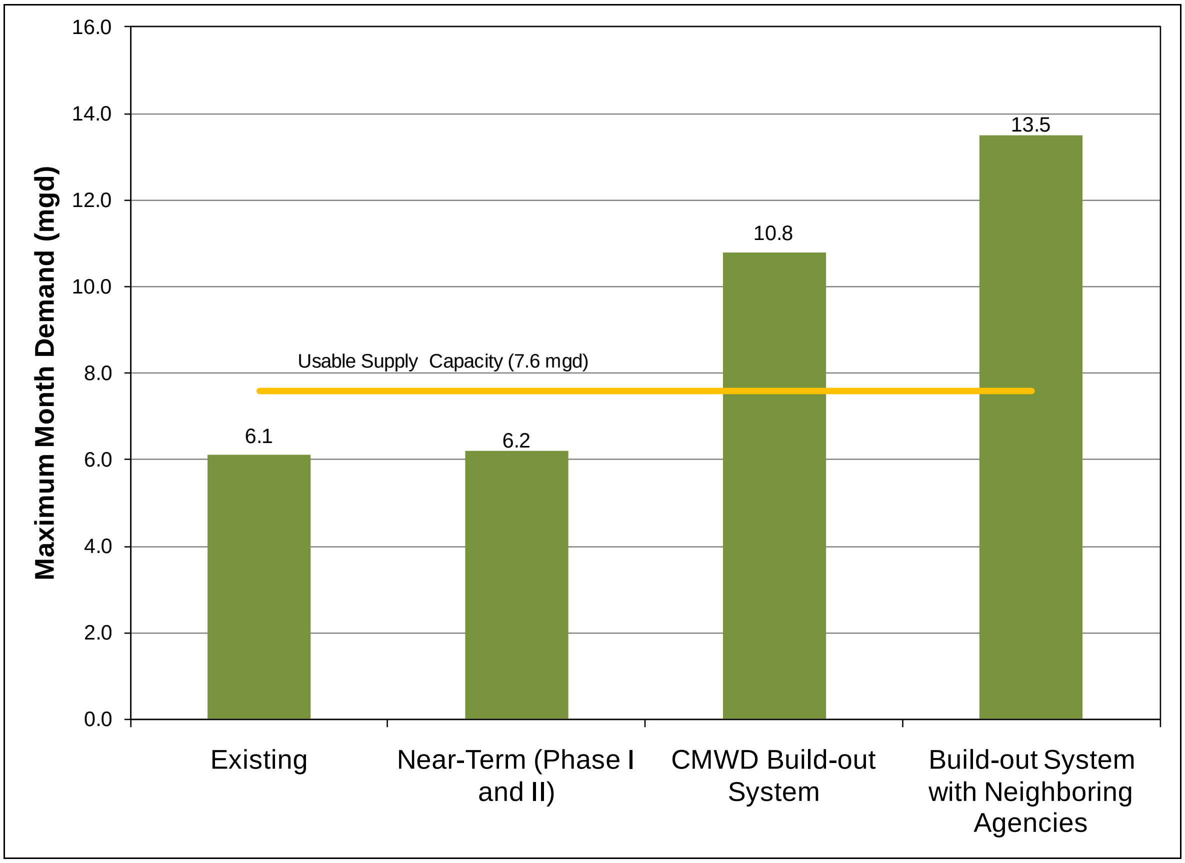


Figure 4.5 Maximum Month Demand

Table 4.5 Summary of Supply Requirements
Recycled Water Master Plan
Carlsbad Municipal Water District

	Near-Term (Phase I and II)		CMWD Build-out System		Build-out System with Neighboring Agencies	
Description	**ADD (mgd)**	**MMD (mgd)**	**ADD (mgd)**	**MMD (mgd)**	**ADD (mgd)**	**MMD (mgd)**
Demand	3.7	6.2	6.4	10.8	8.1	13.5
Existing Supply Capacity	7.6	7.6	7.6	7.6	7.6	7.6
Supply Balance	**+3.9**	**+1.4**	**+1.2**	**-3.2**	**-0.5**	**-5.9**

As shown in Table 4.5, CMWD will experience a supply shortfall of just over 3 mgd when all potential customers are connected within the CMWD service area, and just under 6 mgd when all potential demands from neighboring agencies are connected. For planning purposes, a MMD supply capacity of 11 mgd is assumed to be required for connection of all feasible customers within CMWD's service area while an MMD supply capacity of 14 mgd is assumed for connection of all feasible customers including those in neighboring agencies. Various alternatives to meet these supply requirements are discussed in the next section.

4.4 SUPPLY EVALUATION

Based on discussions with CMWD staff, six different supply alternatives were developed. Each alternative has an assumed total build out supply capacity of 14 mgd, based on the demands presented in Chapter 3 and the feasibility study discussed in Chapter 9. The unit supply cost of each alternative as expressed in dollars per acre-foot ($/af) was used for relative comparison purposes. The six supply alternatives that will meet the 14-mgd capacity goal are summarized in Table 4.6.

Table 4.6 Supply Alternatives Summary
Recycled Water Master Plan
Carlsbad Municipal Water District

	Treatment Flow(1) (mgd)					
Supply Source Facility	**Alternative 1 Maximize CWRF**	**Alternative 2 Maximize MWRF**	**Alternative 3 Maximize GWRP**	**Alternative 4 Abandon GWRP**	**Alternative 5 Maximize CWRF and Lake Calavera**	**Alternative 6 Utilize Shadowridge WRP**
Carlsbad WRF	10.25	9.75(3)	7.00	11.00	9.00	9.75
Meadowlark WRF	3.00	3.50	3.00	3.00	3.00	3.00
Gafner WRP(4)	0.75	0.75	4.00	-	0.75	0.75
Calavera Reservoir SWTF	-	-	-	-	1.00	-
Seasonal Storage	-	-	-	-	0.25	0.20
Shadowridge WRP	-	-	-	-	-	0.30
Total	**14.00**	**14.00**(5)	**14.00**	**14.00**(5)	**14.00**	**14.00**

Notes:
WRF = Water Reclamation Facility; WRP = Water Reclamation Plant; SWTF = Stormwater Treatment Facility
(1) Treatment Flow under MDD conditions. For Alternative 6, Shadowridge WRP would have a treatment capacity of 1.0 mgd, but would only supply 0.3 mgd under MDD conditions.
(2) MMD for Gafner WRP did not occur during the same month as MMD for Carlsbad WRF and Meadowlark WRF during 2010. Note that although Gafner WRP's allocation is 0.75 mgd, it is not connected to the rest of the system and is currently only able to supply La Costa Resort and Spa south golf course).
(3) OMWD would be connected to the CMWD system thus freeing capacity at the Meadowlark WRF; however, in addition to the expansion shown here, CWRF would need to be expanded to accommodate the additional 1.4 mgd of OMWD demands planned to be supplied from MWRF for a total CWRF plant capacity of 11.15 mgd.
(4) Demands for Gafner WRP assumed connection of Gafner WRP to the rest of the system for all alternatives except Alternative 4.
(5) Total does not include additional expansion capacity of 1.4 mgd allocated to OMWD from CWRF

The treatment processes and other improvements such as, pipelines and booster pump stations are summarized by supply source in Table 4.7. The capacity and size of the required expanded facilities varies for each alternative as described in the following sections.

Table 4.7 Facilities Required for Expansion
Recycled Water Master Plan
Carlsbad Municipal Water District

Supply Source	**Required Facilities**(1)	
Carlsbad WRF	Tertiary Filters(2) Chlorine Contact Basins	Effluent Pumping(3)
Meadowlark WRF(5)	-	-
Gafner WRP(4)	Tertiary Filters Chlorine Contact Basins	Influent Force Main Effluent Pumping Transmission Main
Calavera Stormwater Facility	Screenings Sedimentation Flocculation Basins	Filtration Rapid Mix Chamber Chlorine Contact Basins Transmission Main(6)
Shadowridge WRP(7)	Headworks Primary Clarifiers Odor Control Facilities Aeration Basins	Blower Building Secondary Clarifiers Tertiary Filters Chlorine Contact Basins

Notes:
(1) Required facilities include associated yard and electrical work.
(2) Carlsbad WRF's existing MF/RO system and filters treat 20 percent and 80 percent of the flow, respectively. Flow from both processes is blended prior to distribution. Expansions are not anticipated to require MF/RO based on discussions with CMWD staff.
(3) Carlsbad WRF currently has 14.4 mgd of effluent pumping capacity (3 duty - no standby)
(4) The 12-inch diameter transmission main proposed in Chapter 9 would need to be increased to a 16-inch diameter transmission main to connect GWRP effluent to CMWD's distribution system. Pipeline size is based on a 3.4-mgd flow since 0.6 mgd will be delivered to the La Costa golf course, which is adjacent to the GWRP.
(5) Since Meadowlark WRF is limited by wastewater influent flow, no expansion is anticipated.
(6) An 8-inch diameter transmission main is required for connecting the stormwater treatment plant to CMWD's distribution system.
(7) As a part of discussions between CMWD and VID, preliminary cost estimates for three alternatives were developed and are discussed in Section 4.4.6. Details on which facilities are included in the expansion were not available. VID's study on reactivation of Shadowridge WRP also discusses alternatives for delivery of the effluent to CMWD's distribution system. These alternatives are discussed in further detail below.

It should be noted that all three water reclamation treatment plants (Carlsbad WRF, Gafner WRP, and Meadowlark WRF) are part of the Encina Wastewater Authority (EWA) and operate off the EWA's joint collection system. At the end of the collection system is the Encina Water Pollution Control Facility (EWPCF) with a flow capacity of 40.5 mgd, a solids capacity of 43.3 mgd, and an ocean outfall with a flow capacity of 43.3 mgd. The EWPCF treats wastewater to secondary treatment standards. The Carlsbad WRF and the Gafner WRP are tertiary scalping plants. Secondary effluent from the EWPCF is pumped to the

Carlsbad WRF and the Gafner WRP for tertiary treatment. EWA also has two wastewater scalping plants upstream in the joint collection system, the Meadowlark WRF and the Shadowridge WRP.

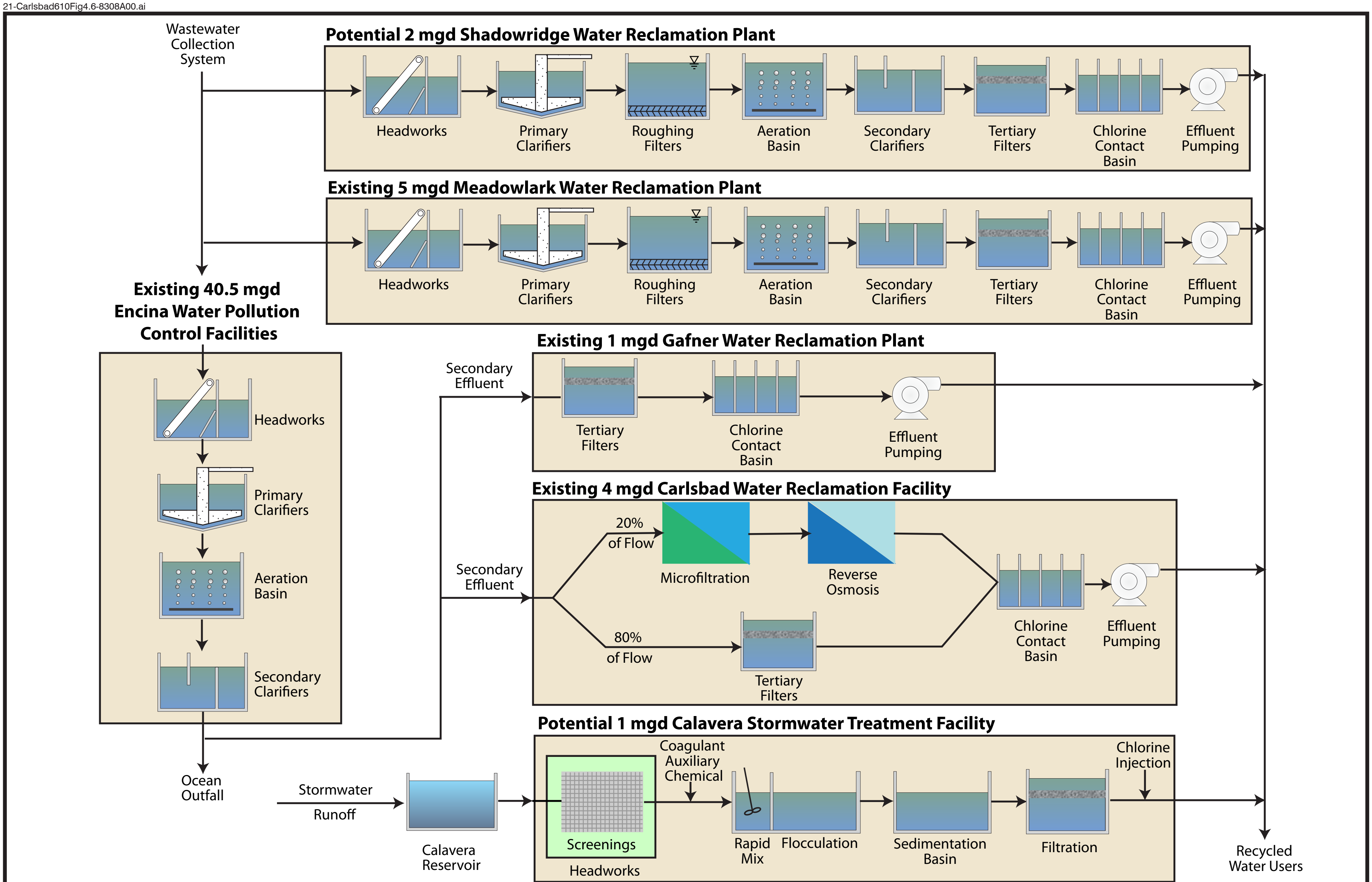
The unit costs for each alternative will be based on the potential annual demand, which is made possible by the expansion. The total existing MMD supply capacity is 7.75 mgd. However, since Gafner WRP is not currently connected to the rest of the system, utilization of the full allocated capacity of Gafner WRP will only be possible if it is connected to the rest of the system. For relative comparison, it is assumed that Gafner WRP will be connected to the rest of the system at build-out and relative costs for the connection are included in each alternative. Based on the seasonal peaking factor of 1.7, the existing MMD supply capacity of 7.6 mgd corresponds to an average annual demand of 5,008 afy. Based on an average annual build-out demand of 9,106 afy, unit costs for each expansion were assumed to add 4,098 afy of potential demand. Note that this unit cost is based on the average annual demand added to the system, not the utilization of the plant.

4.4.1 Alternative 1 – Maximize Carlsbad WRF

This alternative consists of CMWD's current supply mix using recycled water from the Carlsbad WRF, Meadowlark WRF, and the Gafner WRP. The capacities of the Gafner WRP and Meadowlark WRF remain as existing in this alternative providing 0.75 and 3.0 mgd, respectively. The use of the Carlsbad WRF is maximized in this alternative, which will thereby provide the balance of the required supply. The Carlsbad WRF is therefore the only plant expansion in this alternative and would need to be increased from 4.0 mgd to 10.25 mgd to provide a combined supply capacity of 14.0 mgd. In addition, a pipeline and pump station are included to connect the Gafner WRP to the rest of the distribution system, allowing full utilization of the 0.75 mgd allocation of Gafner WRP.

As stated previously, the Carlsbad WRF was originally sized to be increased up to 16 mgd, and it is therefore assumed that all expansions can be accommodated at the current site.

The process flow diagrams for each plant are shown on Figure 4.6. As EWPCF already has a secondary treatment capacity of 40.5 mgd, only tertiary treatment processes, disinfection, and effluent pumping capacity needs to be upgraded as part of this alternative. As the plant already has 14.4 mgd (10,000 gpm) of effluent pumping capacity, no additional effluent pumping capacity is needed to meet MMD. However, if the Carlsbad WRF is used to meet Peak Hour Demands (PHD), additional pumping capacity will be needed. Based on discussions with CMWD staff, Carlsbad WRF will not require spare pumping capacity since Mahr Reservoir can be used to supply Carlsbad WRF in event of a pump outage.



PROCESS FLOW DIAGRAMS

FIGURE 4.6

To determine the capital construction cost of this alternative, the following key components were included:

- 6.25 mgd tertiary filter capacity expansion at Carlsbad WRF.
- 6.25 mgd chlorine contact basin capacity expansion at Carlsbad WRF.
- No additional effluent pumping capacity at Carlsbad WRF.
- 1,500 feet of 8-inch diameter pipeline and 75 hp pump station sized for 0.75 mgd to convey flow from Gafner WRP to distribution system (future Expansion Segment 8 in El Camino Real).

The estimated capital cost of this alternative is $10.8 million. Based on a 30-year repayment period and 6-percent interest, the annual cost is estimated at about $785,000. A detailed breakdown of this estimate is included in Appendix B. Assuming an annual demand of 4,098 afy made possible by this expansion, the unit supply cost of this alternative is hereby estimated at $191/af.

4.4.2 Alternative 2 - Maximize Meadowlark WRF

This alternative consists of CMWD's current supply mix using recycled water from the Carlsbad WRF, Meadowlark WRF, and the Gafner WRP. The utilization of Gafner WRP would again increase in this alternative since Gafner WRP would be connected to the system providing 0.75 mgd during MMD conditions. The use of Meadowlark WRF is maximized by taking the available 3.5 mgd of supply versus the current 3.0 mgd.

This alternative therefore assumes that OMWD would no longer take supply from Meadowlark WRF, but instead obtain recycled water from the Carlsbad WRF through CMWD's distribution system. This would require OMWD to modify its distribution system by adding several booster pumping stations to obtain flow from lower zones in its distribution system. The Carlsbad WRF would also need to be expanded to provide the balance of the required supply for both CMWD and OMWD.

Based on discussions with OMWD staff, OMWD's existing demands are 700 afy, anticipated to increase to 1,300 afy in the future. As discussed in Chapter 3, the customer database includes 500 afy for OMWD delivered in the lower zones. Since the 500 afy is already accounted for within CMWD's build-out demand of 9,106 afy, the remaining additional demand, which would need to be supplied from Carlsbad WRF, would be 800 afy. Based on a seasonal peaking factor of 2.0 (specific to OMWD's system), the estimated MMD would be 1.4 mgd.

The Carlsbad WRF is the only plant expansion in this alternative and would need to be increased from 4.0 to 11.15 mgd to provide an additional 5.75 mgd for CMWD and 1.4 mgd to OMWD.

It is assumed that the proposed expansion of the Carlsbad WRF from 4 mgd to 11.15 mgd can be accommodated at the current site and that this expansion will be limited to the tertiary treatment processes, disinfection, and effluent pumping capacity. As the plant already has approximately 14.4 mgd of effluent pumping capacity, it is not anticipated that the pump station will need to be expanded to meet a MMD of 11.15 mgd. However, if the pump station at Carlsbad WRF is used to meet PHD, additional pumping capacity will be needed.

To determine the capital construction cost of this alternative, the following key components were included:

- 5.75-mgd tertiary filter capacity expansion at Carlsbad WRF.
- 5.75-mgd chlorine contact basin capacity expansion at Carlsbad WRF.
- No additional effluent pumping capacity at Carlsbad WRF.
- Transmission main from CMWD's distribution system to OMWD's distribution system (the 12-inch diameter, 5,500-foot long pipeline proposed along El Camino Real in Chapter 9 would need to be increased in size to 16 inches in diameter).
- Two booster pumping stations within OMWD's system, so that OMWD can take supply from its lower zones.
- 1,500 feet of 8-inch diameter pipeline and 75 hp pump station sized for 0.75 mgd to convey flow from Gafner WRP to distribution system (future Expansion Segment 8 in El Camino Real).

The overall capital cost of this alternative is estimated at $16.9 million. A detailed breakdown of this estimate is included in Appendix B. Assuming an annual demand of 4,098 afy made possible by this expansion, the unit supply cost is estimated at $300/af.

This alternative would be more feasible if Meadowlark WRF wastewater influent flows would increase in the near future, creating a new supply source without the need of expanding CWRF for OMWD. However, this alternative is not possible given the anticipated influent flows to Meadowlark WRF.

4.4.3 Alternative 3 - Maximize Gafner WRP

This alternative consists of CMWD's current supply mix using recycled water from the Carlsbad WRF, Meadowlark WRF, and the Gafner WRP. The Meadowlark WRF remains at its current capacity in this alternative, providing 3 mgd. The use of Gafner WRP is maximized by increasing the supply capacity to 4 mgd. As Gafner WRP treats secondary effluent from the EWPCF, this plant expansion would only require additional Microfiltration and Reverse Osmosis Treatment, disinfection, and effluent pumping. MF/RO treatment would be used to both accommodate limited space constraints and water quality constraints. The use of this additional supply would require the installation of 5,000 feet of

12-inch diameter pipeline along El Camino Real from the Gafner WRP to the intersection with Aviara Parkway. This pipeline, along with a new booster pumping station, would provide a direct connection with Zone 384. This 3-mgd booster station would need to provide sufficient head to deliver recycled water into Zone 384 to serve other customers in CMWD from Gafner WRP. It should be noted that the basin plan for the La Costa Golf Course area, between El Camino Real and Highway 78 (Batiquitos Hydrologic Sub Area 4.51), does not have any limits on TDS and Manganese. When Gafner WRP is expanded and used to serve new CMWD customers, more stringent regulations from other basin plans apply. Water quality could therefore be a potential issue when maximizing this supply source.

In addition, the Carlsbad WRF would be expanded to provide the balance of the required supply. The Gafner WRP and Carlsbad WRF would be expanded by 3.0 mgd each, to provide a combined supply capacity of 14.0 mgd (since Gafner WRP would be connected to the system, it is assumed that the full capacity of 1.0 mgd could be used).

It is assumed that the proposed expansion of the Carlsbad WRF from 4.0 mgd to 7.0 mgd can be accommodated at the current site and that this expansion will be limited to the tertiary treatment processes, disinfection, and effluent pumping capacity. As the plant already has approximately 14.4 mgd of effluent pumping capacity, no additional pumping capacity at Carlsbad WRF is anticipated. However, if the pump station at Carlsbad WRF is used to meet PHD, additional pumping capacity will be needed.

To determine the capital construction cost of this alternative, the following key components were included:

- 3-mgd treatment plant upgrade at the Gafner WRP using MF/RO and chlorine contact basins for disinfection.
- 3.4-mgd discharge pumping station to serve Zone 384. A supply of 0.6 mgd will continue to be delivered to the La Costa Golf Course.
- Replace secondary effluent force main from EWPCF supplying Gafner WRP influent (estimated at 16-inch diameter, 27,000 feet).
- 3-mgd tertiary filter capacity expansion at Carlsbad WRF.
- 3-mgd chlorine contact basin capacity expansion at Carlsbad WRF.
- Transmission main from Gafner WRP to CMWD's distribution system (the 12-inch diameter, 5,000-foot long pipeline proposed along El Camino Real in Chapter 9 would need to be increased in size to 16 inches in diameter).

The estimated capital cost of this alternative is $73.6 million. A detailed breakdown of this estimate is included in Appendix B. Assuming an annual demand of 4,098 afy made possible by this expansion, the unit supply cost of this alternative is estimated at $1,305/af.

4.4.4 Alternative 4 - Abandon Gafner WRP

This alternative is similar to Alternative 1; however, it eliminates the use of Gafner WRP. Consequently, the Carlsbad WRF would need to be expanded to provide the entire balance of the required supply of 14.0 mgd for CMWD. The Carlsbad WRF is the only plant expansion in this alternative and would need to be increased from 4.0 to 11.0 mgd to provide an additional 7.0 mgd for CMWD. This expansion includes the 0.6 mgd to replace lost capacity from the Gafner WRP.

Similar to Alternative 1, it is assumed that the proposed expansion of the Carlsbad WRF from 4.0 mgd to 9.7 mgd can be accommodated at the current site and that this expansion will be limited to the tertiary treatment processes and disinfection. As the plant already has approximately 14.4 mgd of effluent pumping capacity, no additional pumping capacity is anticipated. However, if the pump station at Carlsbad WRF is used to meet PHD, additional pumping capacity will be needed.

To determine the capital construction cost of this alternative, the following key components were included:

- 7-mgd tertiary filter capacity expansion at Carlsbad WRF.
- 7-mgd chlorine contact basin capacity expansion at Carlsbad WRF.
- No additional effluent pumping capacity at Carlsbad WRF.
- 1,500 feet of 8-inch diameter pipeline to convey flow from the distribution system to the Gafner WRP site to supply La Costa Resort and Spa south golf course demands.

The proposed pipeline size in Chapter 9 is predicted to have sufficient capacity to convey the La Costa Resort and Spa south golf course (Gafner WRP's only existing customer) MMD of 0.6 mgd in addition to the demands associated with Expansion Segment 8.

The estimated capital cost of this alternative is $10.2 million. A detailed breakdown of this estimate is included in Appendix B. Assuming an annual demand of 4,098 afy made possible by this expansion, the unit supply cost of this alternative is estimated at $181/af. Note that costs for abandonment of Gafner WRP and the cost benefit of wholesale costs to LWWD are not considered.

4.4.5 Alternative 5 - Maximize Carlsbad WRF and Lake Calavera

This alternative expands CMWD's current supply mix by developing a new supply source from Lake Calavera while continuing to use recycled water from the Carlsbad WRF, Meadowlark WRF, and the Gafner WRP. Meadowlark WRF remains at current capacity in this alternative providing 3.0 mgd. Gafner WRP is connected to the distribution system, allowing full utilization of the 0.75 mgd allocation. Carlsbad WRF is expanded from 4.0 mgd to 9.0 mgd. The balance of 0.25 mgd is assumed to be supplied from seasonal storage in the peak month.

In addition, the stormwater impounded in Lake Calavera is utilized in this alternative by providing a stormwater treatment facility that would treat this water during the peak summer months (July through September) to provide additional supply. Per the CMWD's 2006 Lake Calavera Annual Management and Daily Operations Plan (CMWD, 2006), the reservoir has a 25-foot operational storage range between 189 ft-msl and 214 ft-msl. This operational storage range provides a total storage capacity of 480 MG. The report also states that the annual dry year runoff into the reservoir varies between 32 and 97 MG. Based on this information, the proposed stormwater treatment plant is sized to treat 90 MG in 90 days, which equates to 1 mgd. The location of this proposed facility is shown on Figure 4.4. Based on similar treatment of surface water sources, the proposed stormwater treatment plant (SWTP) is outlined based on a conventional treatment process involving a rapid mix chamber, coagulation in a flocculation basin, sedimentation, filtration, and chlorine addition. This process assumes that the water in Lake Calavera has characteristics typical of a surface water supply. During planning and design of a potential plant, the processes used could change depending on the measured water quality of Lake Calavera.

To connect this new SWTP with CMWD's recycled water distribution system, 4,000 feet of 8-inch diameter pipeline along between the Calavera Reservoir and "C" Tank needs to be constructed as shown on Figure 4.4. This pipeline along with a new booster pumping station would provide a direct connection with Zone 384 and pump into the C-tank feedline. Connection to Zone 580 is not an option due to the limited maximum month demand (<0.4 mgd) of this pressure zone.

The Carlsbad WRF would be expanded by 5.0 mgd to provide the balance of the required supply. It is assumed that the proposed expansion of the Carlsbad WRF from 4.0 mgd to 9.0 mgd can be accommodated at the current site and that this expansion will be limited to the tertiary treatment processes and disinfection capacity. As the plant already has approximately 14.4 mgd of effluent pumping capacity, no additional pumping capacity is anticipated. However, if the pump station at Carlsbad WRF is used to meet PHD, additional pumping capacity will be needed.

To determine the capital construction cost of this alternative, the following key components were included:

- 1-mgd stormwater treatment plant (SWTP) with microfiltration and UV disinfection.
- 1-mgd discharge pumping station at the new SWTP to serve Zone 384.
- 4,000 feet of 8-inch diameter pipeline between the Calavera Reservoir and "C" Tank.
- 5-mgd tertiary filter capacity expansion at Carlsbad WRF.
- 5-mgd chlorine contact basin capacity expansion at Carlsbad WRF.
- No expansion of effluent pumping capacity at Carlsbad WRF.

- 1,500 feet of 8-inch diameter pipeline and 75 hp pump station sized for 0.75 mgd to convey flow from Gafner WRP to distribution system (future Expansion Segment 8 in El Camino Real).

The estimated capital cost of this alternative is $18.9 million. A detailed breakdown of this estimate is included in Appendix B. Assuming an annual demand of 4,098 afy made possible by this expansion, the unit supply cost of this alternative is estimated at $335/af.

4.4.6 Alternative 6 - Utilize Shadowridge WRP

This alternative also expands CMWD's current supply mix by securing water from a new supply source, while continuing to use recycled water from the Carlsbad WRF, Meadowlark WRF, and the Gafner WRP. Meadowlark WRF remains at current capacity in this alternative providing 3.0 mgd. Gafner WRP is connected to the distribution system, allowing full utilization of the 0.75 mgd allocation. Seasonal storage is used for 0.2 mgd of MMD supply.

In addition, this alternative would utilize recycled water from a reactivated Shadowridge Water Reclamation Plant (SRWP), the location of which is shown on Figure 4.4. The VID is currently evaluating the necessary improvements required for reactivating the plant and has discussed the potential alternatives with CMWD. The two potential alternatives evaluated by VID's study that would provide recycled water to CMWD's system are shown in Table 4.8 (a third alternative supplied recycled water only to VID's service area).

Table 4.8 Alternatives for Expansion of Shadowridge WRP
Recycled Water Master Plan
Carlsbad Municipal Water District

Shadowridge WRP Alternative(1)	Plant Capacity (mgd)	Supply to CMWD(2) (mgd)	Unit Cost(3) w/ O&M ($/acre-foot)	Unit Cost w/o O&M ($/acre-foot)
Alternative 2	1.0	0.7	$1,520	$714
Alternative 3	2.0	1.7	$1,070	$567

Notes:
(1) Alternative 1 does not consider service to CMWD's recycled water system.
(2) These flows are average annual supply. See discussion below for further information.
(3) Source: Draft Summary of Shadowridge WRF Upgrade and Renovation Alternatives. VID's reactivation study assumed Carlsbad would purchase all excess water. See discussion below for further information.

As seen in Table 4.8, the anticipated average annual supply to CMWD would be 0.7 mgd and 1.7 mgd under Alternatives 2 and 3, respectively. It is important to note that under each of the alternatives, the calculations of unit cost assume that CMWD will purchase all recycled water not used by the Shadowridge Golf Course.

As shown in Table 4.8, VID's study also included operations and maintenance costs. Since the comparison presented in this section for each supply alternative presents capital costs, the operations and maintenance costs are deducted in Table 4.8 for relative comparison purposes. Operations and maintenance costs by supply source will be included in Section 4.4.8.

Since the demand of the Shadowridge Golf Course will peak in the summer and be very low in the winter months, the availability of this supply will be opposite from CMWD's seasonal supply requirements, as shown in Table 4.9.

Table 4.9 Seasonal Supply Related to Shadowridge WRP
Recycled Water Master Plan
Carlsbad Municipal Water District

	Average Day (mgd)	Maximum Month(1) (mgd)	Minimum Month(2) (mgd)
CMWD's Existing Demand	3.6	6.1	0.7
Build Out Demand (with Neighboring Agencies)	8.1	13.5	1.6
Supply with Alternative 2	0.7	0.3	1.0
Supply with Alternative 3	1.7	1.3	2.0

Notes:
(1) Discussions with CMWD staff indicated that demands of the Shadowridge Golf Course during Maximum Month demand conditions are anticipated to be 0.7 mgd.
(2) Source: Draft Summary of Shadowridge WRF Upgrade and Renovation Alternatives. VID's reactivation study assumed Carlsbad would purchase all excess water. See discussion below for further information. Discussions with CMWD staff indicated that demands of the Shadowridge Golf Course during Minimum Month demand conditions are anticipated to be zero.

As shown in Table 4.9, even under the build-out conditions, the minimum month demand of 1.6 mgd would still be less than the 2.0 mgd supply during minimum months from Shadowridge WRP (Alternative 3). As the unit costs shown in Table 4.8 necessitate that CMWD purchase all excess water generated by Shadowridge WRP, CMWD would not be able to take supply from Meadowlark WRF while paying for its full allotment of 2 mgd. Based on this, Shadowridge WRP Alternative 3 is not financially feasible and Alternative 2 was used for this study. It should be noted that CMWD's build-out minimum month demand would still under utilize supply from Meadowlark WRF under this alternative.

Carlsbad WRF would be expanded by 5.75 mgd to provide the balance of the required supply. It is assumed that the proposed expansion of the Carlsbad WRF from 4 mgd to 9.75 mgd can be accommodated at the current site and that this expansion will be limited to the tertiary treatment processes, disinfection, and effluent pumping capacity. As the plant already has approximately 14.4 mgd of effluent pumping capacity, additional pumping capacity is not anticipated. However, if the pump station at Carlsbad WRF is used to meet PHD, additional pumping capacity will be needed.

The unit costs shown in Table 4.8 do not include conveyance from Shadowridge WRP to CMWD's distribution system. As a part of discussions with VID, several alternatives for delivery of recycled water from the Shadowridge WRP to CMWD's system were suggested. The two most feasible of these delivery methods were:

- Conveyance by gravity through Shadowridge WRP's existing failsafe pipeline to Carlsbad WRF, where it would need to be pumped back up to Zone 550.
- Construction of a pump station at Shadowridge WRP to supply the recycled water to Zone 660. The capacity to transfer the additional supply from Zone 660 to Zone 550 would need to be developed within the infrastructure of CMWD's distribution system.

Table 4.10 Preliminary Costs for Delivery from Shadowridge WRP
Recycled Water Master Plan
Carlsbad Municipal Water District

Cost Component	Alternative 1: Gravity Flow to El Camino Real and Palomar Airport Rd.	Alternative 2: Pressurized Flow to Zone 660 at Melrose Dr. and Faraday St.
Pump Station		
Size (hp)	70	60
Cost	$660,000	$550,000
Transmission Main	$190,000	$750,000
PRS	-	$50,000
Total	**$850,000**	**$1,350,000**

Based on the preliminary cost estimate shown in Table 4.10, it is estimated that conveyance through the gravity pipeline would be the most cost-effective solution and will be used for comparison costs for this supply alternative. Alternative 2 is the more costly option due to the additional transmission main improvements required to convey flow through Zone 660 and a new pump station that would be needed at Shadowridge WRP.

To determine the capital construction cost of this alternative, the estimated capital costs from VID's reactivation study were combined with the conveyance and expansion costs for Carlsbad WRF. The following key components were included:

- 1-mgd reactivation of Shadowridge WRP (cost from VID study).
- 1-mgd pump station to Zone 550 at the delivery point from Shadowridge WRP (near El Camino Real and Palomar Airport Road).
- 750 feet of 12-inch diameter pipeline between the failsafe pipeline, pump station, and distribution system.
- 5.75-mgd tertiary filter capacity expansion at Carlsbad WRF.
- 5.75-mgd chlorine contact basin capacity expansion at Carlsbad WRF.
- No additional effluent pumping capacity at Carlsbad WRF.

- 1,500 feet of 8-inch diameter pipeline and 75 hp pump station sized for 0.75 mgd to convey flow from Gafner WRP to distribution system (future Expansion Segment 8 in El Camino Real).

The estimated capital cost of this alternative is $22.8 million. A detailed breakdown of this estimate is included in Appendix B. Assuming an annual demand of 4,098 afy made possible by this expansion, the unit supply cost of this alternative is estimated at $404/af.

4.4.7 Supply Evaluation Summary

A summary of the supply alternatives evaluation is shown in Table 4.11 and graphically presented on Figure 4.7.

Table 4.11 Supply Alternatives Cost Comparison
Recycled Water Master Plan
Carlsbad Municipal Water District

	Treatment Flow (mgd)					
Supply Source Facility	**Alternative 1** **Maximize CWRF**	**Alternative 2** **Maximize MWRF**	**Alternative 3** **Maximize GWRP**	**Alternative 4** **Abandon GWRP**	**Alternative 5** **Maximize CWRF and Lake Calavera**	**Alternative 6** **Utilize Shadowridge WRP**
Carlsbad WRF	10.25	9.75	7.00	11.00	9.00	9.75
Meadowlark WRF	3.00	3.50	3.00	3.00	3.00	3.00
Gafner WRP(4)	0.75	0.75	4.00	-	0.75	0.75
Calavera Reservoir SWTF	-	-	-	-	1.00	-
Seasonal Storage	-	-	-	-	0.25	0.20
Shadowridge WRP	-	-	-	-	-	0.30
Total Supply (mgd)	**14.00**	**14.00**	**14.00**	**14.00**	**14.00**(5)	**14.00**
Capital Cost ($ million)	**$10.8**	**$16.9**	**$73.6**	**$10.2**	**$18.9**	**$22.8**
Unit Cost(1) ($/acre-foot)	**$191**	**$300**	**$1,305**	**$181**	**$335**	**$404**

Notes:
WRF = Water Reclamation Facility; WRP = Water Reclamation Plant;
SWTF = Stormwater Treatment Facility
(1) Unit Cost based on average supply capacity of 9,106 afy (an increase of 4,098 afy from the current supply of 5,008 afy).

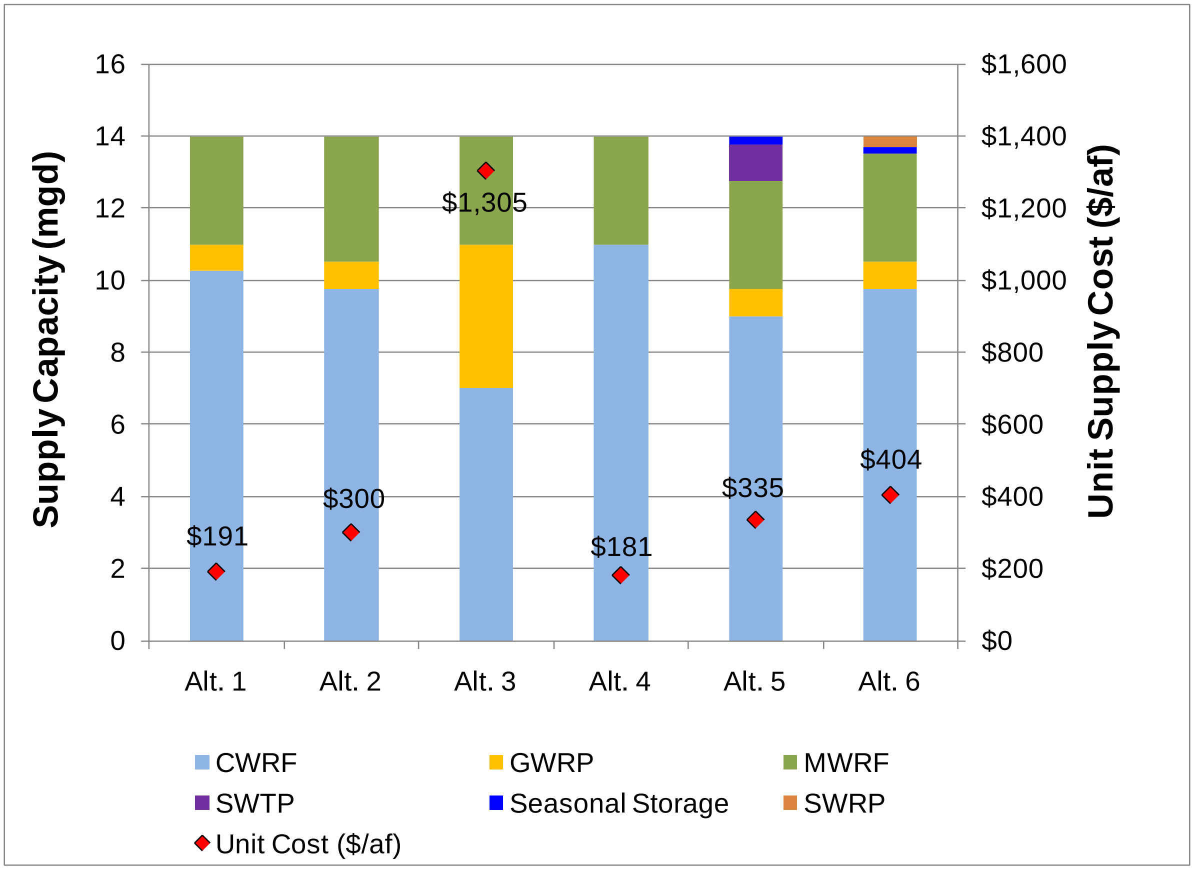


Figure 4.7 Supply Alternatives Comparison

As shown on Figure 4.7, the majority of the recycled water supply capacity is produced at the Carlsbad WRF in all alternatives, ranging from 7 to 11 mgd of the total 14-mgd supply capacity. This figure clearly shows that the variations between alternatives are determined by the supply mix of the remaining 3 to 7 mgd of the total 14-mgd supply capacity.

In addition to the supply mix of each alternative, Figure 4.7 also shows the estimated unit capital supply cost in dollars per acre-foot. These unit supply cost are based on the project components discussed in Sections 4.4.1 through 4.4.6, which are presented in more detail in Appendix B. The total capital costs of each alternative are depreciated over a 30-year period and amortized with a 6 percent interest rate. As shown in Figure 4.7, the estimated unit supply costs range from $181/af to $1,305/af. It should be noted that this cost does not include the cost of secondary treatment at EWPCF, land acquisition costs, existing costs of recycled water, nor operations and maintenance cost of treatment and distribution system facilities.

Based on the capital unit supply cost comparison, it can be concluded that Alternative 4 is the most cost-effective alternative and that Alternative 1 is a close second-best alternative. However, it should be noted that this evaluation does not include O&M cost, which is discussed in the next section. A final recommendation is therefore made at the end of this chapter. Some additional benefits of Alternatives 1 and 4 are:

- Carlsbad WRF was originally designed to be expanded to 16 mgd and the facility layout and distribution system are designed with this ultimate capacity in mind. Carlsbad WRF has therefore sufficient land available for expansion.
- Carlsbad WRF has the necessary treatment processes and configuration to remove TDS and manganese to acceptable levels through the microfiltration and reverse osmosis process that treats 20 percent of the total flow. Note that it is assumed that expansion of the microfiltration and reverse osmosis process is not necessary and the long-term efficiency of use of the microfiltration and reverse osmosis process to treat manganese should be evaluated during design of the expansion.
- Carlsbad WRF is owned and operated by CMWD and therefore does not require any inter-agency agreements. CMWD will have more control over the expansion, operation, and maintenance of this facility compared to the Gafner WRP or Meadowlark WRF, which are owned and operated by other agencies.

Alternative 2 maximizes the use of the Meadowlark WRF at 3.5 mgd. This alternative would require CMWD to obtain all the supply rights from this plant from OMWD. This would only be feasible if OMWD obtained more recycled water from CMWD's distribution system, which would require an expansion of the Carlsbad WRF similar in size to Alternative 1. OMWD could purchase recycled water from CMWD through a new connection pipeline along El Camino Real that would connect CMWD's Zone 384 with OMWD's recycled water system near La Costa Golf Course as OMWD already has infrastructure in place south of this golf course. Moreover, Alternative 2 would also require OMWD to construct one or more booster pump stations to deliver water from the new connection to their higher pressure zones, which are currently fed by gravity from Mahr Reservoir and the Meadowlark WRF. As this supply strategy is not attractive for operational, design, and reliability considerations, it is not likely that OMWD would exchange supply from Meadowlark WRF with supply from Carlsbad WRF. Due to the uncertainty of OMWD's expansion plans and schedule, it is recommended that CMWD not plan for additional supplies from the Meadowlark WRF.

Alternative 3 is not recommended as it is the most expensive alternative in $/af. The relatively high cost is attributed to the required MF/RO treatment required for the plant expansion at the Gafner WRP, due to Gafner WRP's limited onsite space. Another factor impacting the cost of this alternative is the water quality constraints as Gafner WRP would need to provide water meeting the TDS requirements of the basin plan.

Alternative 5 is not recommended as the SWTP and pipeline make this alternative relatively costly as it would only operate potentially 7 months per year during a wet year. In addition, treated stormwater may pose water quality concerns and variable lake levels may cause environmental concerns and could require mitigation measures. With sufficient secondary effluent and potential treatment capacity available at the Carlsbad WRF, the use of runoff water in Lake Calavera as a recycled water supply source is not cost-effective at this time.

Alternative 6 is not recommended since it is more costly than Alternatives 1, 2, 4, and 5, but does not provide the benefit of maintaining facilities under CMWD's own control. CMWD is able to take advantage of economies of scale in expanding the Carlsbad WRF more efficiently than reactivating the Shadowridge WRP, while not being concerned with interagency agreements and coordination to ensure that the Shadowridge WRP operates at capacity to meet a contracted 1-mgd delivery of recycled water. This alternative would also underutilize the Meadowlark WRF in the near-term, making the overall supply cost even higher.

4.4.8 Unit Cost Comparison by Supply Source

In addition to the comparison of supply alternatives, the unit supply cost for each supply source was calculated to take into account the purchase agreements for recycled water from neighboring agencies as well as the operations and maintenance costs paid by CMWD. The unit costs for each supply source are shown in Table 4.12. Note that the flows shown are based on full utilization of each source, and thus are not necessarily comparable to the unit costs shown in the previous section.

As shown in Table 4.12, Carlsbad WRF is CMWD's lowest cost supply source when considered on a unit cost basis. Meadowlark WRF is CMWD's second lowest cost supply source. Note that Gafner WRP and Meadowlark WRF both have minimum purchase agreements, below which unit costs of supply will effectively increase. It is assumed that Shadowridge WRP would have a similar agreement.

Table 4.12 Supply Source Unit Cost Comparison
Recycled Water Master Plan
Carlsbad Municipal Water District

	Unit Cost ($/af)			
Supply Source Facility	**Based On**	**Capital**	**O&M**	**Total**
Carlsbad WRF(1)	10.25 mgd	$259	$249(2)	$508
Gafner WRP(3)	0.6 mgd			$988
Meadowlark WRF(4)	2.67 mgd	$80	$481	$561
Shadowridge WRP(5)	0.7 mgd	$715	$805	$1,520
Calavera SWTF(6)	1 mgd	$610	$448	$1,058

Notes:
(1) Based on cost estimate for expanding Carlsbad WRF from 4 mgd to 10.25 mgd (Alternative 1) and existing capital recovery; incorporates effluent pumping cost to Zone 384. The unit cost of 259 $/af includes 68 $/af for the existing capital recovery associated with 4 mgd of capacity and 191 $/af for future capital recovery associated with the 6.25 mgd expansion. The O&M unit cost of $249 includes $78 associated with fixed costs and $171 associated with non-fixed costs. Note that this supply comparison assumes 5,725 afy utilization of the treatment plant capacity. Actual utilization may be substantially less due to peaking and the timeline of connecting customers.
(2) Derived from Encina JPA FY08/09 costs listed in Encina JPA FY10/11 budget and supply volume from CMWD sales report to MWD for FY08/09. It was assumed that personnel and internal service fund costs would be similar to current costs. Non-personnel expenses, such as energy, chemicals, and repairs were assumed to scale based on utilization of Carlsbad WRF.
(3) Based on current 2010 rate set at 99% of CMWD potable water rate and minimum purchase of 395 afy (0.35 mgd) of recycled water. Based on wholesale rate; no consideration of capital and O&M costs are included. Note that unit cost would also be applicable to supply of 0.75 mgd if capital costs for connection are excluded.
(4) Based on capital recovery and O&M percentages listed in August 20, 2003 agreement with VWD and VWD operating budget for FY10/11. Assumed purchase of 2,989 afy.
(5) Costs based on preliminary cost estimate of PBS&J study on reactivation of Shadowridge WRP. Assumed minimum purchase of 728 afy.
(6) O&M cost are based on typical water treatment O&M costs from AWWA/WEF QualServe performance measurement program ($1,373 per MG processed). Calavera supply is 276 afy or 90 MG.

4.4.9 Potable Water Supplement Alternative

CMWD’s existing facilities have sufficient capacity to accommodate existing and future customers through build out conditions for a portion of the year. However, the supply capacity is insufficient to meet the peak demands during the summer. The supply Alternatives 1 through 6 presented previously all provided combinations of treatment plant expansions to meet the build out recycled water demand with tertiary treated water. However, another alternative is to not build any new facilities and use potable water to supplement the recycled water supply during peak months. This option is referred to as the Potable Water Supplement Alternative and is compared with Alternative 4 to determine if it is cost-effective for CMWD should expand its treatment facilities.

This comparison is based on the incremental treatment capacity needed to serve a build out demand of 9,106 afy. As the existing treatment facilities can serve about 5,008 afy and meet the seasonal demand needs, the incremental treatment capacity or potable water supplement capacity is based on an annual demand of 4,098 afy.

To evaluate the cost effectiveness of using potable supplement water for seasonal peaking, the annual amount of supply in excess of the existing supply capacity was calculated based on a build-out demand of 9,106 afy. Based on the historical seasonal demand variation shown in purple on Figure 4.8, the required amount of potable supplement water was estimated at 2,271 afy.

As it is anticipated that the build out demand of 9,106 afy will be reached around year 2030, the need and cost of potable supplement water will increase over time. To estimate the cost of this alternative, the potable water rate projected by SDCWA for year 2018 was used. This year represents the approximate time that about half of the remaining customers are connected, a few years before completion of Phase III. This is also SDCWA's furthest year out for which a rate projection is available. SDCWA estimates that their wholesale rate will reach $1,757 per afy by 2018. Based on this wholesale rate and an annual potable water supplement demand of 2,271 afy, the annual cost of this alternative is estimated at nearly $4 million. This equates to a unit supply cost of $974/af using an annual demand of 4,098 afy.

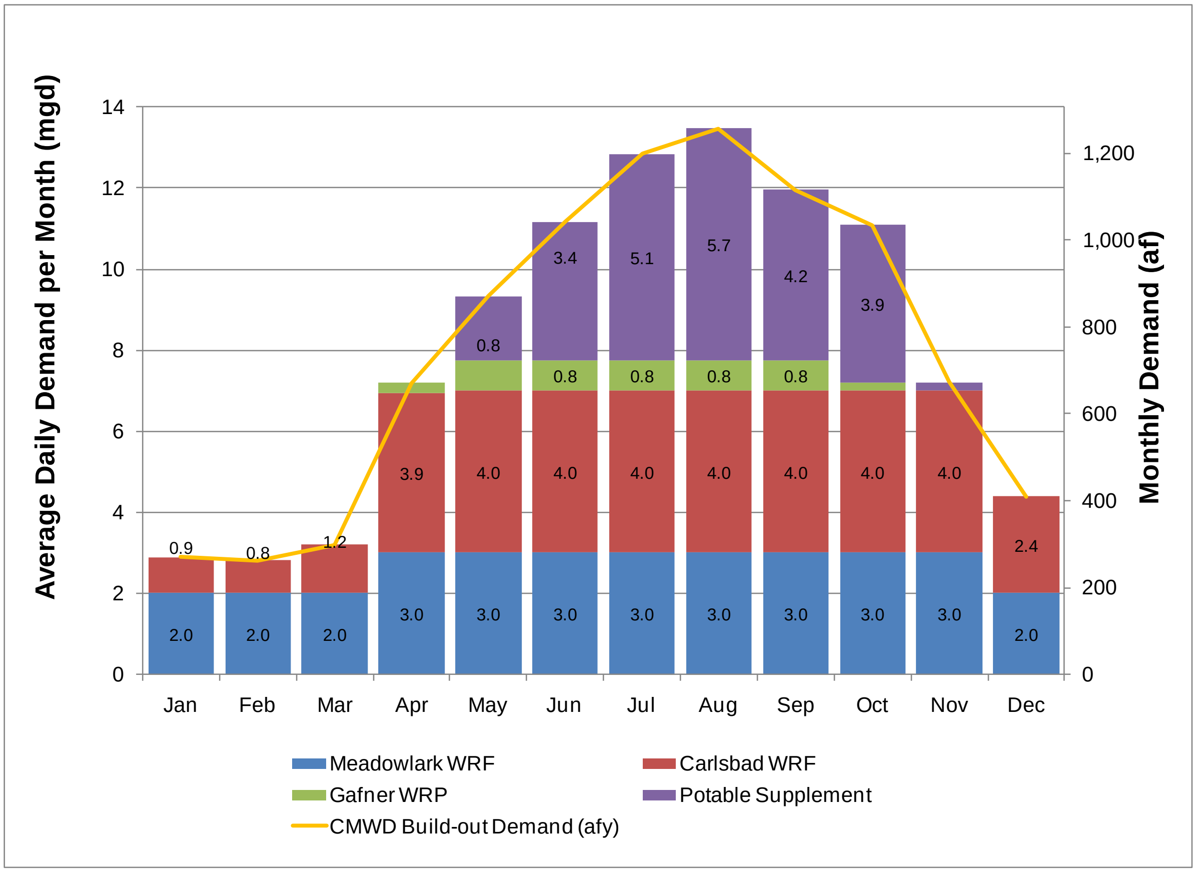


Figure 4.8 Required Potable Supplement as Seasonal Supply

Table 4.13 presents a comparison of using potable supplement water with the capital and O&M cost associated with serving the incremental demand of 4,098 afy through an expansion of Carlsbad WRF as recommended in Alternative 4. The cost of Alternative 4 includes $181/af for capital expansion as shown in Table 4.11. In addition, the demand weighted O&M cost for operating the treatment plant expansion is about $377/af. The combined cost of Alternative 4 is therefore estimated at $568/af.

Table 4.13 Comparison of Potable Water Supplement with Alternative 1
Recycled Water Master Plan
Carlsbad Municipal Water District

Cost Component	Potable Water Supplement Alternative(1)	Alternative 4 6-mgd Carlsbad WRF Expansion(2)
Capital Cost ($)	-	$10,800,000
Annual Cost ($/year)	$3,990,147	$785,000
Unit Cost ($/af)	$974(3)	$568(4)

Notes:
(1) Based on annual demand of 9,106 afy for build out. Assumed to have negligible capital costs (potentially, additional potable supplement water through an air gap).
(2) Based on annual demand of 9,106 afy for build-out of CMWD service area and neighboring agencies.
(3) Unit cost only reflects the cost of 4,098 afy of wholesale treated water and does not include the unit cost for the other supply sources needed to meet the annual demand of 9,106 afy.
(4) Based on $191 per af for capital recovery of the Carlsbad WRF expansion; $78 per af for fixed O&M costs at Carlsbad WRF; $171 per af for non-fixed costs at Carlsbad WRF; $377 per af for O&M and $481 per af for Meadowlark WRF

As shown in Table 4.13, Alternative 4 is much more cost-effective than purchasing potable supplement water. This comparison does not include the cost of supplying up to 5,008 afy with the existing facilities, as those costs will be the same for both alternatives. This analysis also does not consider the loss of MWDSC's LRP reimbursement, energy cost due to elevation difference between the potable water connection and Carlsbad WRF.

It should be noted that the use of potable supplement water may be practical and required on an incidental basis, but that this is not a valid long-term supply strategy, especially when potable water rates continue to increase over time.

4.4.10 Recommended Supply Alternative

The recommended alternative for expanding recycled water supply is Alternative 4, which calls for a 7-mgd treatment plant expansion at the Carlsbad WRF. Alternatively, CMWD may want to consider Alternative 1, which calls for a 6.25-mgd treatment plant expansion at Carlsbad WRF.

The expansion of Carlsbad WRF will need to be implemented based on the phasing of demands and expansion segments discussed in Chapter 9. Phasing of each increment of expansion of the treatment plant and the associated supply strategy will be discussed in more detail in Chapter 9.

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RECYCLED WATER REGULATIONS

The production, discharge, distribution, and use of recycled water are subject to federal, state, and local regulations. The primary objective of these regulations is to protect public health. This chapter starts with a discussion of the roles and responsibilities of the agencies involved in the use of recycled water. Subsequently, the existing regulations on federal, state, regional, and local level are described. This chapter is concluded with a discussion on future regulations and the impact to the Carlsbad Municipal Water District (CMWD).

5.1 OVERVIEW OF REGULATING AGENCIES

The 1996 Memorandum of Agreement (MOA) between the California Department of Public Health (CDPH), the State Water Resources Control Board (SWRCB), and the Regional Water Quality Control Boards (RWQCBs) allocate the primary areas of responsibility and authority between these agencies on the use of recycled water. The CDPH is the primary state agency responsible for public health, whereas the SWRCB and the RWQCBs are the primary state agencies charged with protection, coordination, and control of surface and groundwater quality. These agencies work together to develop plant discharge or master reclamation permits for recycled water projects. Generally, the CDPH interprets the laws dictated by the California Code of Regulations (CCR) applicable to reclamation and makes recommendations on individual projects to the RWQCB. The RWQCB issues the final permit for water reclamation projects. In addition, in the County of San Diego, the CDPH has delegated the review of proposed recycled water use areas, use site distribution plans, complete cross connection control shutdown testing, and use site inspections to the County's Department of Environmental Health (DEH). The roles of the agencies involved in the management of recycled water are summarized in Table 5.1.

5.2 FEDERAL REGULATIONS

While wastewater discharges are governed by both federal and state requirements, currently there are no federal regulations that directly govern water recycling practices in the United States.

Federal regulations relevant to the discharge of recycled water, wastewater, and any other liquid wastes to "navigable waters" are contained in the 1972 amendments to the federal Water Pollution Control Act of 1956, commonly known as the federal Clean Water Act (Public Law 92-500).

Table 5.1 Roles of Agencies Involved in Recycled Water Use
Recycled Water Master Plan Update
Carlsbad Municipal Water District

Responsibility	CDPH	RWQCB	City of Carlsbad	RW Customer	DEH
Treatment Facility					
Review treatment plant design criteria	x	**X**			
Title 22 Engineering Report	x	**X**			
Treatment Plan Inspections	x	**X**			
Discharge Permits	x	**X**			
Enforcement actions for non-compliance	x	**X**			
Distribution System					
Review for standards compliance	x		**X**		
Recycled water permits		**X**			
Annual Title 17 Inspections	**X**				
Backflow prevention device testing			**X**	x	
Review cross-connection programs	x				
Customer Site Areas					
Develop standards for use areas			**X**		x
Review/approve supplier rules and regulations	x	**X**			
On-site inspection	x	x	**X**		**X**
Cross-connection inspection			**X**	**X**	**X**
Cross-connection testing			**X**	**X**	**X**
Monitoring on-site use			**X**	**X**	x
Enforcement actions for non-compliance		x	**X**		x

Notes:
Source: California-Nevada Section American Water Works Association (AWWA, 1997)
X = Entity with primary responsibility
x = Entity with secondary responsibility

Federal requirements relevant to the use of recycled water for groundwater recharge are contained in the 1986 amendments of the Safe Drinking Water Act of 1974 (Public Law 93-523). The Safe Drinking Water Act focuses on the regulation of drinking water and control of public health risks by establishing and enforcing maximum contaminant levels (MCLs) for various compounds in drinking water.

5.3 STATE REGULATIONS

State requirements for production, discharge, distribution, and use of recycled water are contained in the:

- California Water Code, Division 7 (Water Quality), Sections 1300 through 13999.16 (Water Code);
- California Administrative Code, Title 22 – Social Security, Division 4 – Environmental Health. Chapter 3 – Water Recycling Criteria, Sections 60301 through 60475;
- California Administrative Code, Title 17 – Public Health, Division 1 – State Department of Health Services, Chapter 5 – Environmental Sanitation, Subchapter 1, Group 4 – Drinking Water Supplies, Sections 7583 through 7630.

In addition, guidelines for the production, distribution, and use of recycled water have been prepared or endorsed by state agencies administering recycled water regulations. A summary of existing and future CDPH statutes and regulations, along with the pertinent available guidance documents, is listed in Table 5.2.

Table 5.2 Summary of California Recycled Water Regulations
Recycled Water Master Plan
Carlsbad Municipal Water District

Regulations
Title 22, Division 4, Environmental Health, Chapter 3
Title 17, Division 1, California Department of Public Health, Chapter 5
Statewide Recycled Water Policy
Statutes
Health and Safety Code, Division 6, Part 1, Sanitary Districts Act of 1923, Chapter 4
Water Code, Division 7, Water Quality, Chapters 7 & 7.5
Draft Legislation
Groundwater Recharge Reuse (August 2009)
Guidance Documents
Preparation of an Engineering Report for the Production, Distribution and Use of Recycled Water

Sources:
(1) http://www.cdph.ca.gov/healthinfo/environhealth/water/Pages/Waterrecycling.aspx (CDPH, 2009a)
(2) http://www.cdph.ca.gov/certlic/drinkingwater/Pages/Lawbook.aspx (CDPH, 2009b)

5.3.1 State Water Code

The Porter-Cologne Water Quality Control Act (CWC – Division 7), which was promulgated in 1969, established the SWRCB as the state agency with primary responsibility for the coordination and control of water quality, water pollution, and water rights. Nine RWQCBs were established to represent the SWRCB regionally and carry out the enforcement of water quality and pollution control measures. In addition, each RWQCB is required to formulate and adopt water quality control plans, establish requirements for waste discharge to waters of the state, and has the authority to carry out provisions of the federal Clean Water Act. The San Diego RWQCB has jurisdiction over the City of Carlsbad.

5.3.2 Code of Regulations – Title 22

In accordance with the requirements of Division 7 – Chapter 7 of the Water Code, CDPH prepared Title 22 in 1975. The current requirements of Title 22, as revised in 1978, 1990, and 2001, regulate production and use of recycled water in California. Title 22 establishes the quality and/or treatment processes required for an effluent to be used for a specific non-potable application, such as irrigation. The following categories of recycled water are identified:

- Undisinfected secondary recycled water
- Disinfected secondary-23 recycled water (23 refers to the coliform count requirement of 23 MPN/100 mL)
- Disinfected secondary-2.2 recycled water (2.2 refers to the coliform count requirement of 2.2 MPN/100 mL)
- Disinfected tertiary recycled water
- Disinfected tertiary recycled water with conventional treatment
- Disinfected tertiary recycled water without conventional treatment

The recycled water uses allowed by Title 22 are dependent on the effluent quality of the supply source. As the effluent of the Carlsbad Water Reclamation Facility (WRF), Meadowlark Water WRF, and the Gafner Water Reclamation Plant (WRP) are all classified as ‘Disinfected Tertiary Recycled Water’ per Title 22, the effluent water quality of each meets or exceeds the criteria listed in Table 5.3.

Table 5.3 Effluent Quality Standards for Unrestricted Use per Title 22
Recycled Water Master Plan Update
Carlsbad Municipal Water District

Treatment	Oxidized, Coagulated (or Filtered), and Disinfected
BOD_5	Not Specified
TSS	Not Specified
Turbidity	2 NTU (Daily Average)
	5 NTU (Maximum during 5% of the time in a 24-hour period)
	10 NTU (Maximum at any time)
Total Coliform MPN(1)	2.2/100 mL (Medium)
	23/100 mL (Maximum in 30 days)

Note:
(1) No sample shall exceed an MPN (most probable number) of 240 total coliform bacteria per 100 milliliters during any 30-day period.

The effluent from the Carlsbad WRF, Meadowlark WRF, and Gafner WRP meet or exceed these requirements. As such, the recycled water may be used for all applications listed in Table 5.4.

Table 5.4 Approved Use Applications for Disinfected Tertiary Recycled Water
Recycled Water Master Plan Update
Carlsbad Municipal Water District

Irrigation Uses
Food crops where recycled water contacts the edible portion of the crop, including all crop roots
Parks and playgrounds
School yards
Residential landscaping
Unrestricted-access golf courses
Food Crops, surface-irrigated, above-ground edible portion, and non contacted by recycled water
Cemeteries
Restricted-access golf courses
Ornamental nursery stock and sod farms with unrestricted public access
Freeway landscaping
Pasture for milk producing animals for human consumption
Nonedible vegetation with access control to prevent use as a park, playground or school yard
Vineyards with no contact between edible portion and recycled water
Non food-bearing trees, including Christmas trees not irrigated less than 14 days before harvest
Fodder and fiber crops and pasture for animals not producing milk for human consumption
Seed crops not eaten by humans
Food crops undergoing commercial pathogen destroying processing before consumption by humans
Any other irrigation uses not prohibited by other provisions of the California Code Requirements
Supply for Impoundment
Non-restricted recreational impoundments, with supplemental monitoring for pathogenic organisms
Restricted recreational impoundments and publicly accessible fish hatcheries
Landscape impoundments without decorative fountains
Supply for Cooling and Air Conditioning
Industrial or commercial cooling or air-conditioning involving cooling tower, evaporative condenser, or spraying that creates mist
Industrial or commercial cooling or air-conditioning not involving cooling tower, evaporative condenser, or spraying that creates mist

Table 5.4	**Approved Use Applications for Disinfected Tertiary Recycled Water** Recycled Water Master Plan Update Carlsbad Municipal Water District

Other Allowed Uses
Flushing toilets and urinals
Priming drain traps
Industrial process water that may contact workers
Structural fire fighting
Decorative fountains
Commercial laundries
Soil compaction
Dust control on roads and streets
Flushing sanitary sewers
Consolidation of backfill material around potable water pipelines
Backfill consolidation around nonpotable piping
Artificial snow making for commercial outdoor use
Commercial car washes, not heating the water, excluding the general public from washing processes
Industrial process water that will not come into contact with workers
Industrial boiler feed water
Non-structural fire fighting
Mixing concrete
Cleaning roads, sidewalks, and outdoor work areas
Other Uses Subject to RWQCB Approval
Groundwater recharge (permits issued on a case-by-case basis by the RWQCBs)

The current Title 22 requirements are also known as the “Purple Book”. The most recent compilation of recycled water laws can be found online [http://www.cdph.ca.gov/certlic/drinkingwater/Pages/Lawbook.aspx].

Regardless of the approved regulatory uses of Title 22 water, CMWD is limited to those uses stated either in its individual permit, or in a general permit that covers multiple users in the area. Currently, under Section B of CMWD’s permit, requirements are only stipulated for landscape irrigation. Other additional uses of recycled water not identified in the permit would need approval from the local RWQCB and CDPH office.

5.3.3 Code of Regulations – Title 17

The focus of Title 17 is protection of (potable) drinking water supplies through control of cross-connections with potential contaminants, including non-potable water supplies such as recycled water. Title 17, Group 4, Article 2 – Protection of Water System, specifies the minimum backflow protection required on the potable water system for situations in which there is potential for contamination to the potable water supply. Recycled water is addressed as follows:

- An air-gap separation is required on “Premises where the public water system is used to supplement the recycled water supply.”
- A reduced pressure principle backflow prevention device is required on “premises where recycled water is used…and there is no interconnection with the potable water system”.
- A double-check valve assembly may be used for “residences using recycled water for landscape irrigation as part of an approved dual plumbed use area unless the recycled water supplier obtains approval from the local public water supplier to utilize an alternative backflow prevention plan that includes an annual inspection and annual shutdown test of the recycled water and potable water systems”.

5.3.4 Draft Groundwater Recharge Legislation

A draft regulation issued on August 8, 2008 specifically addresses Groundwater Recharge Reuse. The regulations address requirements for the engineering report and monitoring and reporting projects that use recycled water for groundwater recharge. Specific requirements included in these draft regulation are as follows:

- Groundwater recharge can only be undertaken with disinfected tertiary recycled water.
- Recharged recycled water must be retained underground for a minimum of six (6) months prior to extraction for use as drinking water supply.
- Monitoring of groundwater is mandated at a location where:
  - recycled water has been retained in the saturated zone for 1-3 months, but will take at least 3 months before reaching the nearest domestic water supply well
  - locations between the recharge area and the nearest down gradient domestic water supply well

5.3.5 Statewide Recycled Water Policy

To reduce the uncertainty of the regulatory requirements for recycled water, the SWRCB adopted a statewide Recycled Water Policy in May 2009 (SWRCB, 2009). The impetus for the development of a statewide Recycled Water Policy stemmed from the current water crisis and a need to streamline and expedite the use of recycled water throughout the state in a manner consistent with existing state and federal laws. The purpose of the policy is to provide direction to the RWQCBs and the public on the appropriate criteria for issuing permits for recycled water projects. The policy follows Title 22 requirements and intends to streamline recycled water use through the following measures:

- **Streamlining of Recycled Water Use Permits.** The policy establishes consistent criteria that are intended to streamline the permitting process for the vast majority of recycled water applications. These criteria should expedite projects and allow the RWQCBs both the time and authority to focus resources on projects with site-specific conditions. Projects that are eligible for enrollment under a general order shall be enrolled within 60 days. Other applications not enrolled in a general order shall be considered for permit adoption within 120 days by the RWQCB if certain criteria are met.
- **Mandated Recycled Water Use.** The SWRCB establishes a statewide mandate to increase the use of recycled water by 200,000 acre-feet per year (afy) by 2020 and by an additional 300,000 afy by 2030. Agencies not providing a downstream beneficial use for recycled effluent are required to make it available on reasonable terms. Existing legislation considers it a waste if recycled water is not utilized when available (Water Code Sections 13550 *et seq.*). As part of this new policy, the SWRCB would exercise its authority pursuant to Water Code Section 275 to enforce the aforementioned mandates. The mandates are contingent on the availability of sufficient capital funding for the construction of recycled water projects from private, local, state, and federal sources.
- **Salt Nutrient Management Plans.** By 2014, all basins are required to develop salt and nutrient management plans (with a two-year extension available). Such plans will help areas meet water quality objectives on a basin wide basis instead of restricting individual recycled water projects. The Basin Plan developed by the Santa Ana Watershed Project Authority (SAWPA) and the Basin Plan being developed by the San Diego County Water Authority (SDCWA) have become examples for the entire state on how to prepare these plans. The salt and nutrient management plans work in conjunction with the Basin Plans, which cover salts as well as other constituents, to preserve the existing groundwater quality.
- **Anti-Degradation.** Projects that use recycled water for groundwater recharge are approved depending on a basin's capacity to assimilate the increased concentrations of chlorides and other compounds that may be present in recycled water. If necessary, projects would need to implement anti-degradation measures in order to gain approval. Recycled water use projects that meet the criteria for streamlined permitting in a basin with a salt and nutrient management plan do not need to perform an anti-degradation investigation. These criteria are defined in detail in the Recycled Water Policy (SWRCB, 2009).
- **Funding.** The SWRCB will request priority funding for storm water and recycled water projects that augment the local water supplies from Department of Water Resources (DWR).

Additional measures are included in the policy to ensure that recycled water use does not adversely affect groundwater basin quality. Such measures include:

- **Monitoring of Groundwater Basins.** The salt and nutrient management plans require the use of monitoring wells to record water quality data, which needs to be submitted to the Regional Board every three years.
- **Constituents of Emerging Concern.** Groundwater recharge projects are required to test and monitor constituents of emerging concern (CECs). A Blue Ribbon Panel has conducted a study on CECs and has prepared a Final Report, which is anticipated to be adopted in 2011. This report has prioritized four compounds for groundwater recharge projects based on their toxicological relevance. These four compounds are caffeine, a female hormone (17beta-estradiol), an antibacterial agent (triclosan), and a disinfection by-product (N-nitrosodimethylamine). These CECs need to be monitored to determine if the concentrations may be cause for any concern. Due to the limited data available on CECs, there are no Action Levels (AL) or MCL established at this time.
- **Control of Incidental Runoff.** Landscaping projects using recycled water are required to control the incidental runoff of recycled water through measures that include, but are not limited to, the following practices: installation and use of proper sprinkler heads; an operations and management plan (can apply to multiple sites); and application of limited irrigation during precipitation events.

If an agency producing recycled water is not using it for a beneficial use as defined in the policy, that agency needs to provide that water to a purveyor on reasonable terms. As CMWD is currently planning to utilize the maximum amount of available recycled water possible, the policy does not have a significant impact on CMWD. CMWD could use the general use permit to streamline the permitting process for future irrigation customers. In addition, CMWD may want to monitor the impact of this policy to determine when any additional funding assistance will be available.

5.3.6 CDPH Guidelines

To assist with the compliance with the requirements outlined in Title 22, the CDPH has prepared a number of guideline documents. Documents relevant to the production, distribution, and use of recycled water are:

5.3.6.1 <u>Engineering Report</u>

According to CWC Section 13522.5, all water purveyors that use, or propose to use, recycled water must prepare an engineering report according to the guidelines described in the *Guideline for the Preparation of an Engineering Report on the Production, Distribution, and Use of Recycled Water*. This guideline is included in Appendix E. This report must be submitted to the appropriate RWQCB and CDPH. The report must describe the recycled water production process, including raw and treated water quality, treatment process, plant reliability features, supplemental water supply, monitoring program, and contingency plan to prevent distribution of inadequately treated water. The report must include maps of the distribution system and describe how the system will comply with CDPH and American Water Works Association (AWWA) guidelines and Title 17. The report must also include maps and descriptions of proposed use areas, types of uses proposed, people responsible for supervising the uses, design of the user systems, and the proposed user inspection and monitoring programs.

5.3.6.2 Cross-Connection Control

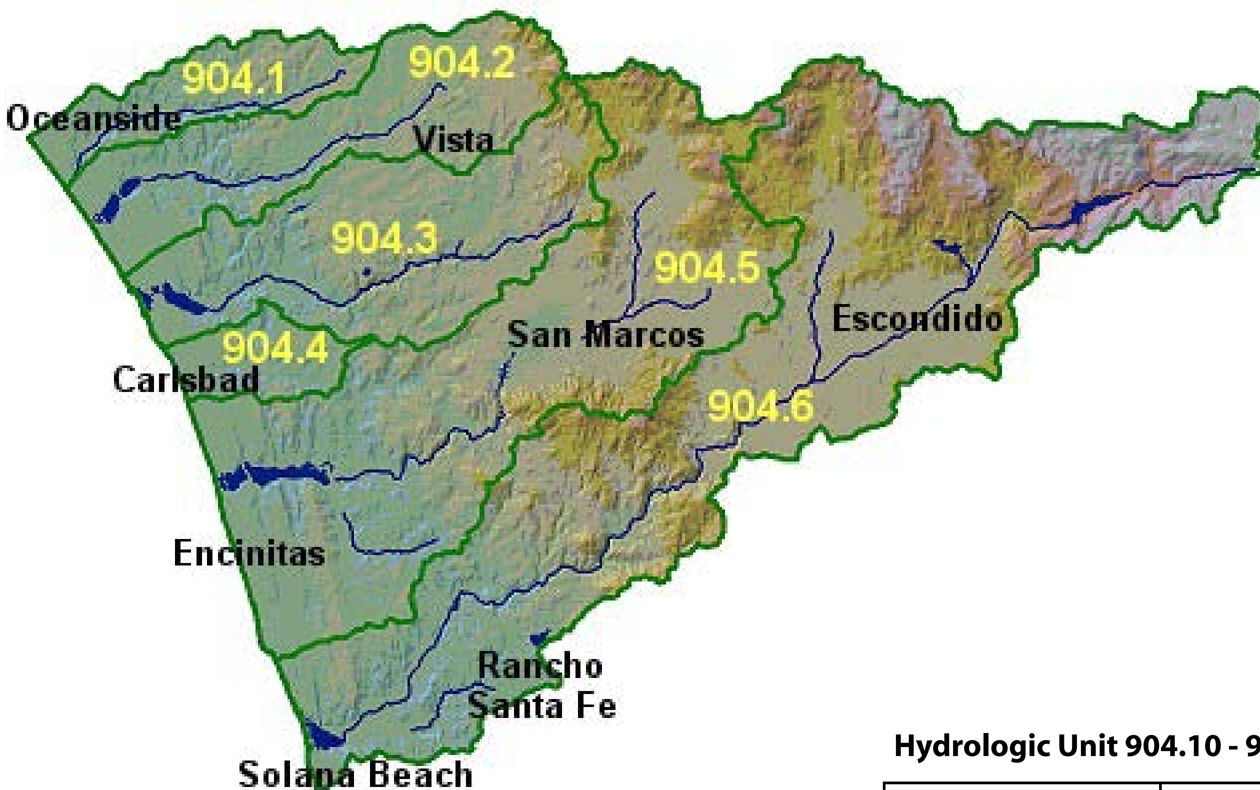
The Manual of Cross-Connection Control/Procedures and Practices was prepared by CDPH in 1981 (and updated periodically) and focuses on establishing a cross-connection control program to protect the public against backflow and back-siphonage of contamination. Main elements of the manual include areas where protection is required, causes of backflow, approved backflow preventers, procedures, installation, and certification of backflow preventers and water shutoff procedures for conditions that pose a hazard to the potable water supply.

It should be noted that the proposed revisions outlined for the Draft California 2010 Plumbing Code – Chapter 16 – Part II dated May 13, 2009 (see Appendix B), prohibit the use of backflow preventers between potable and recycled water systems and specifies that a recycled water system shall not have any connections to a potable water system (Section 1613.0 under A).

5.4 REGIONAL WATER QUALITY CONTROL BOARD

While CDPH provides input to protect public health, the RWQCB created provisions in a permit for the protection of beneficial uses of water and the protection of water quality. These provisions are based on the Water Quality Control Plan the RWQCB has adopted, otherwise known as the Basin Plan. The Basin Plan is the RWQCB guide for the protection of the beneficial uses of water and the enhancement of water quality. This document provides water quality objectives for continued beneficial use of water resources. This study's area of interest falls within Basin Plan hydrological unit 904.00, which is divided into five hydrologic subareas (HSAs). A map of the Basin location is shown in Figure 5.1. For this hydrologic region, the groundwater constituent limits from the Basin Plan are listed in Table 5.5. Groundwater constituent concentrations cannot exceed these limits more than 10 percent of the time during any one-year period.

21-Carlsbad510Fig5.1-8308A00.ai



Hydrologic Unit 904.10 - 904.63

Hydrologic Areas:	Loma Alta	904.1
	Buena Vista Creek	904.2
	Agua Hedionda	904.3
	Encinas	904.4
	San Marcos	904.5
	Escondido Creek	904.6

Carlsbad Watershed

FIGURE 5.1

carollo
Engineers...Working Wonders With Water™

CARLSBAD MUNICIPAL WATER DISTRICT

Table 5.5	**Basin Plan Groundwater Quality Objectives** Recycled Water Master Plan Update Carlsbad Municipal Water District				
Constituent (mg/L or as noted)	**El Salto HSA (904.21)**	**Los Manos HSA(1,2,3) (904.31)**	**Encinas HSA(1,4) (904.40)**	**San Marcos HSA(5) (904.50)**	**Batiquitos HSA(1,5,6) (904.51)**
Total Dissolved Solids	3,500	3,500	3,500	1,000	3,500
Chloride	800	800	800	400	800
Sulfate	500	500	500	500	500
Percent Sodium	60%	60%	60%	60%	60%
Nitrate (as NO_3)	45	45	45	10	45
Iron	0.3	0.3	0.3	0.3	0.3
Manganese	0.05	0.05	0.05	0.05	0.05
Methylene Blue Active Substances	0.5	0.5	0.5	0.5	0.5
Boron	2.0	2.0	2.0	0.75	2.0
Fluoride	1.0	1.0	1.0	1.0	1.0

Notes:
Source: RWQCB, San Diego Region, Comprehensive Quality Control Plan for the San Diego Basin
(1) The water quality objectives do not apply westerly of the easterly boundary of Interstate 5.
(2) Notwithstanding the Basin Plan water quality objectives, the Regional Board will regulate discharges in HAS 904.31 in a manner that will protect the waters produced by existing operating wells.
(3) The water quality objectives apply to the portion of HSA 4.31 bounded on the west by the easterly boundary of El Camino Real.
(4) Detailed salt balance studies are recommended for determining limiting mineral concentration levels for discharge. Upon completion of the salt balance studies, significant water quality objective revision may be necessary. In the interim period of time, projects involving groundwater recharge with water quality inferior to the listed values may be permitted following individual review and approval by the Regional Board if such projects do not degrade existing groundwater quality to the aquifers affected by the recharge.
(5) The water quality objectives do not apply to HSA 904.51 between Highway 78 and El Camino Real, and to all lands that drain to Moonlight Creek and Encinas Creek. The objectives for the remainder of the HSAs are shown.
(6) The water quality objectives apply to the portion of HSA 904.51 bounded on the south by the north shore of Batiquitos Lagoon, on the west by the easterly boundary of Interstate 5 right-of-way, and on the east by the easterly boundary of El Camino Real.

When issuing a recycled water reclamation or discharge permit, the RWQCB considers the water quality objectives in the Basin Plan. Typically, constituents cannot exceed the limit set forth by the Basin Plan for each hydrologic region. For Carlsbad, the water quality limits for the Carlsbad WRF, Meadowlark WRF, and Gafner WRP are defined in the respective wastewater discharge permits, which are included in Appendix E. The Carlsbad WRF master permit (Order No. 2001-352) includes the water quality limits that apply to the entire CMWD service area. These limits are summarized in Table 5.6.

When comparing Table 5.5 and Table 5.6, it can be concluded that the Master Reclamation Permit requirements are more stringent for most constituents than the goals set forth in the Basin Plan.

Table 5.6	**Master Reclamation Permit Requirements** Recycled Water Master Plan Update Carlsbad Municipal Water District		
Constituent	**Daily Maximum (mg/L)**	**30-Day Average (mg/L)**	**12-Month Average (mg/L)**
Total Dissolved Solids (TDS)	1,200	-	1,100
Chloride	400	350	-
Sulfate	400	-	350
Boron	0.75	0.75	0.75
Iron	0.4	0.3	0.3
Manganese	0.06	-	0.05
Fluoride	-	-	1.0
Methylene Blue Active Substances (Surfactant)	-	-	0.5

Note:
Source: Master Reclamation Permit for Carlsbad Water Recycling Facility (RWQCB, 2001), included in Appendix E.

The Master Reclamation Permit issued to CMWD also contains numerous requirements for the purveyance of recycled water. These include:

- Requirements for the initiation of recycled water service to a new customer including:
  - Develop rules and regulations governing the design and construction of recycled water use facilities (this is already in place)
  - Develop a compliance inspection program (this is already in place)
  - Submit irrigation plans to the CDPH and/or DEH for new connections
- Requirements subsequent to the initiation of recycled water service but prior to the delivery of recycled water including:
  - Submit a report to the CDPH and DEH certifying that the new user site conforms with documentation previously sent to the CDPH and DEH
  - Conduct a complete cross-connection shut down test for each new use site
  - Verify that reclamation treatment facilities meet RWQCB requirements
- Ongoing requirements for all reuse sites after the start of service including:
  - Enforce recycled water rules and regulations
  - Conduct recycled water reuse site compliance inspections
  - Notify the DEH and CDPH of any recycled water backflow into the potable system
  - Maintain a current list of all on-site recycled water supervisors

5.5 LOCAL REGULATIONS

Local regulations discussed in this chapter include regulations from San Diego County and CMWD.

5.5.1 County of San Diego Regulations

The County of San Diego also has specific regulations governing the inspection and implementation of recycled water connections, contained in the *Recycled Water Plan Check and Inspection Manual (DEH 2001 Edition).* In San Diego County, the plan check and inspection responsibilities are shared between CDPH and the County of San Diego DEH. CDPH is responsible for the plan review of treatment processes, treatment plants, main conveyance systems, and proposed new and unusual uses of recycled water. In conjunction with CMWD staff, the DEH is responsible for plan review and inspections of all recycled water use sites.

Off-Site Requirements:

- **Minimum Separation/Proximity of Utilities:** Vertical separation requirements must be met if the pipeline maintains a positive pressure during the day.
- **Horizontal Separation:** A 10-foot horizontal separation must be maintained between a recycled water pipeline and a sewer main or water pipeline. Separations smaller than 10 feet need approval from CMWD and/or the CDPH depending on the separation distance. The state now only requires a 4-foot horizontal separation between a disinfected tertiary treated recycled water pipeline and a potable pipeline.
- **Vertical Separation:** A potable water line must be installed at least 1 foot above a recycled water line, which must be installed at least 1 foot above a sanitary sewer.

On-Site Requirements:

- **Separation:** At the user site, the separation of utilities is similar to the off-site requirements, but individual purveyors may modify the required on-site distances. Areas of potable water irrigation and recycled water irrigation must be physically separated either by distance, concrete mow strips, or other approved methods, such as fences or walls.
- **Minimum Depth:** The minimum pipeline depth is defined in the City's landscape manual and is as follows:
  - Pressured pipeline less than 3 inches in diameter require 18-inch cover
  - Pressured pipeline between 3 and 5.5 inches in diameter require 24-inch cover
  - Pressured pipeline of 6 inches and greater in diameter require 36-inch cover
  - Non pressured pipelines require 12-inch cover

- **System Identification.** All appurtenances related to the system (sprinkler heads, valve boxes, tags, quick couplers, etc.) must be color coded purple. All valve boxes shall be tagged with recycled water tags. On retrofit jobs, underground piping does not need to be changed.

- **Sprinkler Location.** Sprinklers located close to swimming pools, eating areas, and sand-filled play areas for children should be of the bubbler non-spray type or have adjustable nozzles. Alternatively, sprinklers can be located so that these areas are not oversprayed. 180-degree turf sprinkler heads adjacent to sidewalks are not acceptable since they overspray and cover 190 degrees.

- **Sprinkler Coverage.** Sprinklers must only cover the designated area. Measures need to be taken to avoid misting and wind blown mist.

- **Drinking Fountains.** Drinking fountains must be protected from recycled water runoff, spray, or mist.

- **Ponds.** If a pond is receiving recycled water, potable water to the pond must be delivered through an air gap. Ponds can have fountains provided that the County's design guidelines are followed.

- **Food Establishments.** Recycled water should not be installed near drive-through windows or outdoor patio eating areas.

- **Hours of Irrigation:** The County's Manual describes standard plan notes requiring hours for irrigation to be between 10:00 p.m. and 6:00 a.m. However, if the recycled water meets tertiary treatment standards, the local water authority may modify the hours for irrigation under the qualification that irrigation during public use periods is supervised. Thus, CMWD could modify the hours of irrigation for customer sites where supervision during public hours is possible.

- **Cross-Connection Testing:** The County's manual also specifies testing procedures and frequency to ensure that there are no cross connections with the potable water system.

5.5.2 District Mandatory Use Ordinance

CMWD currently has an ordinance mandating the use of recycled water in accordance with California Water Code, Sections 461, 13510, and 13550. This ordinance is included in Appendix E of this report and summarized below.

The ordinance recognizes that recycled water can reduce dependence on imported water and that certain uses of potable water may pose a nuisance where recycled water is available. Accordingly, the ordinance declares that recycled water shall be used within the jurisdiction wherever it is economically justified, financially and technically feasible, and consistent with legal requirements for preservation of public health, safety and welfare, and the environment.

CMWD is responsible for making the preliminary determination as to which existing potable water customers shall be converted to recycled water. Notice of this determination is sent to the customer, and upon receipt the customer has 90 days to submit an implementation plan to CMWD. The cost for the preparation of this plan should be paid by the customers with the exception of customers that decide to ask CMWD to prepare this plan and are willing to sign an acknowledgement to accept and install the proposed improvements in the plan prepared by CMWD. Once approved, the plan must be implemented within six months. The customers have 30 days to contest any preliminary determination after notice of receipt.

As part of the application process for a new development project, CMWD staff review planning documents to determine if the proposed development requires recycled water, if the proposed development should include provisions for future recycled water use, or if the development is considered suitable for recycled water. Provisions for a current or future recycled water connection may be required as a condition of approval. In addition, applications for remodeling of a property may also be reviewed for recycled water use feasibility. If the property in question is considered suitable for existing or future recycled water use, the use of recycled water may be conditioned on the remodeling application.

The ordinance also specifies CMWD policies for requested recycled water service, plan approval, field inspection, temporary use of potable water (until recycled water is available), and the recycled water rate.

The ordinance is adequate for CMWD's purposes as it defines CMWD's authority in requiring recycled water use, clearly lists criteria for identifying potential users, and outlines the process for new customer connections.

5.5.3 District Regulations and Design Standards

CMWD has also developed rules and regulations for the use of recycled water. These rules and regulations are in included in the following three chapters of CMWD's General Design Standards, Volume 2 – Potable and Recycled Water Standards (CMWD, 2010):

- **Chapter 2 – Rules and Regulations for Use of Recycled Water:** This chapter sets forth the general requirements and conditions as well as the administrative requirements pertaining to the use of recycled water in CMWD as required by the Master Reclamation Permit, the CDPH, and the DEH.
- **Chapter 3 – Design Guidelines and Procedures:** This chapter provides the design procedures, planning and design criteria, as well as the specifications for the location, type, and size of water facilities.

- **Chapter 5 – Requirements for Onsite Recycled Water Systems:** This chapter defines the design requirements, construction specifications, and operational requirements for onsite (private) recycled water systems.

5.6 FUTURE REGULATORY DEVELOPMENTS

Future regulatory considerations for the use of recycled water consist of the anticipated updates to the Draft Groundwater Recharge Reuse Regulations and the 2010 California Plumbing Code. In addition, there are developments on the regulation of endocrine disrupting compounds (EDCs) and other CECs.

5.6.1 Groundwater Recharge

As described in Section 5.3.4, the CDPH issued Draft Groundwater Recharge Reuse Regulations in August 2008 that contain treatment requirements for projects with an indirect potable reuse or recharge component (CDPH 2008). These requirements have been implemented for past projects and require such constraints as a minimum underground detention time. The Title 22 Regulations currently call for RWQCBs to review groundwater recharge projects on a case-by-case basis with input from CDPH. These draft regulations will be finalized in the future. Further information regarding the development of these draft regulations can be found on the CDPH website (CDPH, 2009).

5.6.2 Updates to the 2010 California Plumbing Code

The California Plumbing Code is being updated to relax the restrictive rules for installing dual plumbing for indoor recycled water use, as well as gray water. These changes pertain to Chapter 16 of Title 24, Part 5 of the California Code of Regulations.

The code revisions for recycled water were approved by the Building Standards Commission and will be part of the 2010 Code. The new rules remove some of the restrictions on the installation of recycled water pipe in buildings. The major features of the new dual plumbing rules are:

- Recycled water pipe can now run in the same wall/ceiling cavity as potable pipe.
- The labeling requirements for purple pipe are relaxed.
- The annual inspection is a visible inspection, followed by a cross-connection test if there is reason to believe there is a cross-connection, rather than an automatic cross-connection test each year.
- The use of potable water for backup supply or makeup water is not allowed. Recycled water systems must be completely separated from potable water systems.

5.6.3 Constituents of Emerging Concern

Recent advances in technology have allowed the detection of constituents that were previously undetected in the environment. Many of these constituents are classified as CECs since they are suspected of possibly posing a public health or ecological risk. CECs are not currently regulated by the Environmental Protection Agency (EPA), but many of these constituents are candidates for future regulations. As more scientific information becomes available, the EPA may impose regulations on some of these constituents. CECs include personal care products and pharmaceutical products. Many of these CECs are also considered EDCs.

The primary concern of CEC is indirect potable reuse. As CMWD does not practice indirect potable reuse, CECs should not be a significant concern for CMWD at this time. Nevertheless, CMWD should be aware of CECs since the public at large has expressed concern with the potential for coming in contact with CECs through contact with edible crops irrigated by recycled water.

As stated in Section 5.3.5, a Blue Ribbon Panel has prioritized four compounds for groundwater recharge projects based on their toxicological relevance. These four compounds are caffeine, a female hormone (17beta-estradiol), an antibacterial agent (triclosan), and a disinfection by-product (N-nitrosodimethylamine).

In addition, other CECs are identified as viable performance indicator compounds, which differ by the type of reuse practice. However, none of the chemicals for which measurement methods and exposure data are available exceeded the threshold for monitoring priority. For irrigation applications, the Panel therefore recommends monitoring emphasis be placed on use of indicator CECs that can demonstrate that the treatment processes employed are effective in removing CECs.

5.6.4 Endocrine Disrupting Compounds

In recent years, there has been heightened scientific awareness and public debate over potential impacts that may result from exposure to EDCs. Humans, fish, and wildlife species could potentially be affected by sufficient environmental exposure to EDCs. This discussion is provided to briefly communicate what is currently known about EDCs and to describe their position within California's recycled water regulations.

EDCs can be either natural or anthropogenic contaminants, which are chemicals that have been introduced to the environment by the activity of man. Plants, such as soybeans and garlic, produce natural EDCs as a defense mechanism. However, most EDCs are man-made synthetic chemicals, which are unintentionally released into the environment. Certain drugs, such as birth control pills, intentionally alter the endocrine system. Categories and sources of substances that are potential EDCs are presented in Table 5.7.

Table 5.7 Potential Endocrine Disrupting Compounds
Recycled Water Master Plan Update
Carlsbad Municipal Water District

Category	Examples of Substances	Examples of Uses	Examples of Sources
Polychlorinated Compounds	Polychlorinated dioxins, Polychlorinated biphenyls	Industrial production of by-products (mostly banned)	Incineration, landfill
Organochlorine Pesticides	DDT, Dieldrin, Lindane	Insecticides (many phased out)	Agricultural runoff
Other Pesticides (current use)	Atrazine, Trifluralin, Permethrin	Pesticides	Agricultural runoff
Organotins	Tributyltin	Antifoulants on ships	Harbors
Alkylphenolics	Nonylphenol	Surfactants (and their metabolites)	Industrial and municipal effluents
Phthalates	Dibutyl phthalate, Butylbenzyl phthalate	Plasticizers	Industrial effluent
Hormones	17-beta estradiol, Estrone	Produced naturally by animals	Municipal effluents
Synthetic Steroids	Ehynylestradiol	Contraceptives	Municipal effluents
Phytoestrogens	Isoflavones, Ligands, Coumestans	Present in plant material	Pulp mill effluents

Source: Canadian Wildlife Service, Pacific Wildlife Research Center (CWS, YEAR).

Regulations Pertaining to EDCs

In 1996, new legislation required that the U.S. EPA “determine whether certain substances may have an effect in humans that is similar to an effect produced by a naturally occurring estrogen or other such endocrine effect.” In response, the EPA developed the Endocrine Disrupter Screening and Testing Advisory Committee. In June 2008, they issued a draft white paper on how criteria for the synthetic birth control estrogen ethinyl estradiol might be developed in the future.

Although some chemicals have been conclusively determined to be EDCs, many chemicals are termed “suspect” because there is not enough data to make a decisive determination regarding their endocrine disrupting characteristics. Some known EDCs (e.g., PCBs, DDT, chlordane) are already regulated via surface water quality standards or drinking water standards based on their toxicological and carcinogenic effects. However, no water quality standards currently exist for natural and synthetic estrogens or related pharmaceutical chemicals. Based on the current state of knowledge regarding dose-response relationships of EDCs for various organisms at the low-levels in which they can occur in surface waters, it is likely to be a number of years, possibly many years, before any such standards are promulgated.

The EPA and other stakeholders looked at 7,500 substances and in December 2009 the EPA released its third contaminant candidate list (CCL3). The CCL3 includes 116 substances (104 chemicals and 12 microbiological contaminants) which are not currently regulated in drinking water by the federal government but may be considered for future regulation under the Safe Drinking Water Act (SDWA). The final CCL3 includes, among others, pesticides, disinfection byproducts, chemicals used in commerce, waterborne pathogens, pharmaceuticals, and biological toxins.

5.7 RECOMMENDATIONS

CMWD currently abides by the stipulations imposed by CDPH through the Master Reclamation Permit, and DEH through CMWD standards found in *Volume II Potable and Recycled Water Standards.* Nevertheless for one DEH requirement, a physical separation between areas of irrigation with recycled and potable water, CMWD could add a qualifying phrase to Item 5.1.3.E of Chapter 5 of the standards to ensure that this physical separation is applied to both large, constantly pressurized pipes and small, intermittently pressurized pipes. After the start of the sentence, “Potable and recycled lines,” CMWD could add the qualifier, “including irrigation laterals.” This could help avoid situations where the physical separation exists for offsite pipes, but not for onsite irrigation laterals.

CMWD staff have mentioned that significant effort is expended complying with the increased oversight requirements of the County. While this regulatory oversight is outside the control of CMWD, decreasing the amount of regulatory oversight would increase CMWD staff’s productivity and efficiency.

In addition, CMWD will want to monitor funding opportunities that may result from the new Recycled Water Policy. Such funding could become available as the State’s budget situation improves.

HYDRAULIC MODEL

This chapter presents an overview of the activities undertaken to develop and calibrate the hydraulic model for Carlsbad Municipal Water District's (CMWD) recycled water distribution system. This chapter contains the following sections:

- Hydraulic Modeling Overview – This section explains the purpose of hydraulic models and modeling software selection.
- Existing System Model Creation – This section describes the model development and the data and processes used to create each hydraulic model.
- Existing System Model Calibration – This section describes the processes used to gather field data and calibrate each model in order to establish a level of confidence in the model results.
- Future System Model Creation – This section describes the additions made to the calibrated model to analyze future system expansion opportunities.

Detailed information on the calibration of each of the models is included in Appendix F, Model Calibration Results. Additional information on the use of the models is included in Appendix G, Model Manual.

6.1 HYDRAULIC MODELING OVERVIEW

Innovations in personal computing and the large selection of software have made network analysis modeling efficient and practical for virtually any water system. Hydraulic modeling is an important tool for analyzing a water system. Hydraulic models can simulate existing and future water systems, identify system deficiencies, analyze impacts from increased demands, and evaluate the effectiveness of proposed system improvements, including those within capital improvement plans. In addition, a hydraulic model provides both the engineer and water system operator with a better understanding of the water system dynamics. Hydraulic models are typically composed of three main parts:

- The data file that stores the geographic location of facilities. The geographic data file provides water system facility locations and is typically represented as an AutoCAD or geographic information systems (GIS) file. Elements used in this file to model system facilities include pipes, junction nodes (connection points for pipes and location of demands), control valves, pumps, tanks, and reservoirs.
- A database that defines the physical system. The database for CMWD's model is linked to the geographic data file. The database includes water system facility information such as facility size and geometry, operational characteristics, and production/consumption data.

- A computer program “calculator”. This calculator solves a series of hydraulic equations based on information in the database file to define and generate the performance of the water system in terms of pressure, flow and operation status.

The key to maximizing benefits from the hydraulic model is correctly interpreting the results so the user understands how the water distribution system is affected by the various components of the model. This understanding enables the engineer to be proactive in developing solutions to existing and future water system goals and objectives. With this approach, the hydraulic model is not only used to identify the adequacy of system performance, but is also used to find solutions for operating the water system according to established performance criteria.

Developing an accurate and reliable computer model begins with entering the best available information into the database and calibrating the model to match existing conditions in the field. Once the model has been calibrated, it becomes a valuable tool to evaluate operational problems and to plan distribution system improvement projects.

6.1.1 Hydraulic Model Selection

Several software programs are widely used to model distribution systems. The variety of program capabilities and features makes the selection of a particular software program generally dependent upon three factors: user preference, the requirements of the particular water distribution system, and the cost associated with the software.

CMWD has selected H_2OMAP® Water, developed by MWH Soft, Inc., for the hydraulic modeling of its recycled water distribution system.

6.1.2 Previous Hydraulic Model

CMWD’s initial hydraulic model of its recycled water distribution system was developed in 2000 as a part of the Encina Basin Recycled Water Distribution System Study (JPA, 2000) using H_2ONET® Version 2.0.

The hydraulic model provided to Carollo Engineers at the beginning of this project was developed by CMWD staff in H_2OMAP® Water.

6.2 EXISTING SYSTEM MODEL CREATION

CMWD provided GIS layers containing relevant information concerning its pipeline network. Since the level of detail and topology of CMWD’s GIS layers was judged to be more representative of the recycled water distribution system than the previous hydraulic model, CMWD’s GIS layers were imported into the hydraulic model rather than the pipelines from the previous hydraulic model. Facilities and controls were then adapted from the previous hydraulic model. In summary, the model creation process involved the following steps:

1. Link Creation. Links were created from CMWD's GIS layers of pipeline elements to represent CMWD's recycled water system.

2. Node Creation. Nodes were automatically generated at the intersections of pipeline segments. Individual nodes representing specific components of the City's recycled water system such as tanks and reservoirs were added.

3. Attribute Data Input. Unique attribute data was assigned to each link and node.

4. Facility Creation. Facilities were imported from the previous hydraulic model and verified through discussions with CMWD staff.

5. Operational Data. Based on the previous hydraulic model as well as discussions with CMWD operations staff, control parameters were assigned to the appropriate links and nodes.

The model operates according to the operational and physical attributes assigned to each node and link. This information is used to simulate flows and pressures within the system as predicted by the model's mathematical equations. A screenshot of the hydraulic model is shown in Figure 6.1.

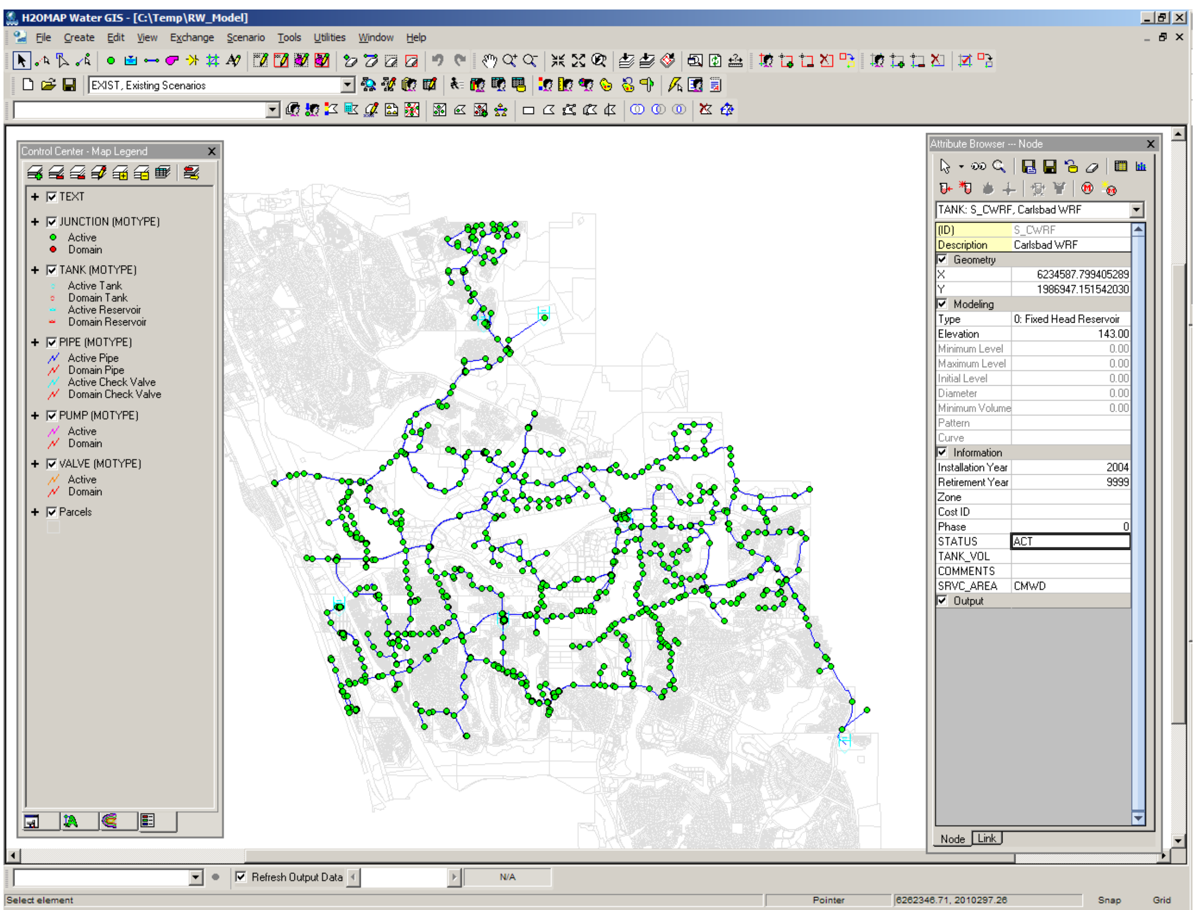


Figure 6.1 Screenshot of Hydraulic Model

6.2.1 Model Links

Hydraulic models consist of links and nodes to model representations of physical system components of a distribution system. Links are used to represent pipes, pumps, and control valves. Pipeline segments represent the actual transmission or distribution water pipelines. In the attribute table for each pipe, data typically includes diameter, length, C-factor, and pressure zone. The model calculator uses the attribute data to determine increases or decreases in energy levels across the link. Some of the reported output data that the model calculates for links include flows, velocities, head loss, and changes in hydraulic grade line.

6.2.2 Model Nodes

Nodes represent the connections between links and may act as either a supply source, such as a reservoir or tank, or a customer demand. Nodes also define the boundaries of each link and separate links that may contain different attributes. Each node also has an elevation that fixes the elevations of the connecting link elements. Attribute data associated with each node typically includes elevation, water demand, and pressure zone. The model calculates system pressures, hydraulic grade lines, demands, and water quality parameters at each node.

6.2.3 Demand Allocation

Demands were initially allocated based on historical billing records for the calendar year 2008. Demands from customer meters were allocated to the existing junction within the hydraulic model nearest the location of the meter in the City’s GIS layer of meters. Demands were updated to 2010 demands for the five largest users, and scaling of the overall demands for remaining users.

Locations of meters for the five largest users were imported directly from the City’s GIS layer of meters, giving the five largest users their own nodes. These meters are assigned the same Meter ID as the City’s GIS layer and the name of the customer is included in the Description field for the junction element.

As shown in Table 6.1, in addition to the demands for all of CMWD’s pressure zones, a demand of 486 gpm (0.7 mgd) was assumed for OMWD to account for the level of Mahr Reservoir. Also, 120 gpm (0.2 mgd) of CMWD’s recycled water demand represents the La Costa Resort and Spa south golf course fed by Gafner WRP and is isolated from the rest of the distribution system.

Table 6.1 Summary of Demands by Pressure Zone
Recycled Water Master Plan
Carlsbad Municipal Water District

Pressure Zone	Elevations Served (ft-msl)	Average Day Demand[1] (gpm)	Average Annual Demand[1] (afy)
660	240' to 460'	193	311
580	200' to 430'	142	229
550	200' to 430'	453	731
384	20' to 380'	1,476	2,381
318	50' to 80'	24	39
Subtotal	***50' to 460'***	***2,287***	***3,690***
La Costa Golf Course	61'	120	194
Subtotal (CMWD's System)	***50' to 460'***	***2,407***	***3,884***
OMWD	N/A	486	784
Total in Hydraulic Model	**50' to 460'**	**2,893**	**4,668**

Note:
(1) Demands are based on 2008 data, as the spatial data for calendar year 2009 was not available at the time of this report preparation.

6.2.4 Elevation Allocation

Elevations were linearly interpolated to all junctions from the City's GIS layer of ground elevation contours. This contour layer has 2-foot intervals.

6.2.5 Attribute Data Information

For junction elements, attribute data was added for the fields DMD_NODE, FACILITYID, FAC_NODE, LARGEUSER, STATUS, LOGGER, and LOGGERID. The LOGGER and LOGGERID fields were added as a part of the calibration process. Descriptions for the junction fields added to the model, as well as their sources, are shown in Table 6.2.

For pipeline elements, attribute data was imported from the City's GIS pipeline layer for the fields Diameter, Material, Zone, Year of Installation, and Facility ID. Descriptions for the fields added to the pipeline elements in the model, as well as their sources, are shown in Table 6.3.

Table 6.2 Junction Attribute Data Fields
Recycled Water Master Plan
Carlsbad Municipal Water District

Field Name	Description	Valid Entries	Source
DMD_NODE	Indicates if a demand is placed on the junction.	Boolean (Yes or No)	Demand Allocation
FAC_NODE	Indicates if the junction is a part of a facility.	Boolean (Yes or No)	Generated by Consultant
LARGEUSER	Indicates if the junction represents the meter of a large user.	Boolean (Yes or No)	City's meter GIS layer
STATUS	Indicates whether a facility is active in the existing system.	ACT, ABAN	City's pipeline GIS layer: "STATUS" Field

Table 6.3 Pipeline Attribute Data Fields
Recycled Water Master Plan
Carlsbad Municipal Water District

Field Name	Description	Valid Entries	Source
DIAMETER	Diameter of pipeline.	Integers	City's pipeline GIS layer: "Diam" Field
MATERIAL	Pipeline material.	ACP, CML&C, DI, STL, PVC (with class)	City's pipeline GIS layer: "PIPETYPE" and "PIPECLASS" Fields
ZONE	Pipeline pressure zone.	318, 384, 550, 580, 660	City's pipeline GIS layer: "PressZone" Field
YR_INST	Year pipeline installed. Adapted from year of "ASBUILT" field. For pipelines with unknown "ASBUILT" field, used "SIGNDATE" field.	Integer, 9999 used for unknown years.	City's pipeline GIS layer: "ASBUILT" and "SIGNDATE" Fields
FACILITYID	Unique identifier. Not included on pipelines not from the City's GIS.	WM#####	City's pipeline GIS layer: "FacilityID" Field
FACILITY	Indicates whether an element is part of a facility (i.e., pipeline segments used for modeling purposes rather than actual pipeline in the ground).	Boolean (Yes or No)	Generated by Consultant
STATUS	Indicates whether a facility is active in the existing system.	ACT, ABAN	City's pipeline GIS layer: "STATUS" Field

6.2.6 Operational Controls

Operational controls were initially obtained from the previous hydraulic model. These controls were discussed with operation staff during the Operations Workshop. The updated system controls discussed in the workshop are presented in Table 6.4.

Table 6.4 Operational Controls
Recycled Water Master Plan
Carlsbad Municipal Water District

Facility	Facility Type	Control Details
Carlsbad WRF	Discharge Pump Station	• Activated by operator. • Generally two pumps on from 10:00 p.m. to 6:00 a.m. • Third pump activated when necessary.
Carlsbad WRF	Equalization Basin	• During the winter and wet weather events, the equalization capacity is used to buffer effluent, as the ocean outfall capacity is limited. • During the summer, the equalization basin capacity is used to buffer diurnal demand variations.
Avenida Encinas PRV	Pressure Regulating Station	• 3-inch diameter PRV set at 113 psi. • 8-inch diameter PRV set at 108 psi.
Twin D	Booster Pump Station	• Four VFD pumps able to be controlled by flow and pressure. • Pumps would turn off if the D Tanks' levels fall below 10 feet.
Twin D	Ralph Valve	• 10-inch diameter FCV/PSV[(1)] with maximum capacity of 3,500 gpm.
Twin D	Potable Makeup Connection	• 8-inch diameter PSV[(2)] with capacity of at least 3,000 gpm. • PSV is set to 74 psi.
La Costa / Poinsettia PRV	Pressure Regulating Station	• 6-inch diameter PRV set at 90 psi. • 8-inch diameter PRV set at 85 psi. • Pressure Relief Valve (not modeled). • This station opens automatically during periods of high demand to supply Zone 384[(3)].

Table 6.4 Operational Controls
Recycled Water Master Plan
Carlsbad Municipal Water District

Facility	Facility Type	Control Details
Bressi PS	Pump Station	• Three VFD pumps controlled primarily by pressure and secondarily by flow. • One 7.5 hp VFD jockey pump operated during periods of low demand(3). • 8-inch diameter Pressure Relief Valve set at 85 psi (not modeled). • This station opens automatically during periods of high demand to supply Zone 384(3).
Faraday PRV	Pressure Regulating Station	• 6-inch diameter PRV. • 10-inch diameter PRV. • Settings for both valves are above an HGL of 384 to assist the Twin D tanks in the north portion of the 384 Zone.
Calavera PS	Pump Station	• Three VFD pumps with a hydro-pneumatic tank. • One 5 hp VFD jockey pump operated during periods of low demand(3). • 8-inch diameter Pressure Relief Valve (not modeled).

Note:
(1) As discussed in Chapter 2, the valve is a combination rate of flow, pressure sustaining, and solenoid control valve, but is controlled by a SCADA based on tank level and demand.
(2) As noted in Chapter 2, the valve is normally closed and can be operated remotely through SCADA.
(3) Controls or facilities were modified after calibration to reflect changes in how CMWD staff operate the system.

Controls for parameters not specified from the operations workshop were either based on the SCADA printouts provided by CMWD, adapted from the previous hydraulic model, or assumed from the existing system HGL.

6.3 EXISTING SYSTEM MODEL CALIBRATION

The purpose of the hydraulic computer model is to estimate or predict how the water system will respond under a given set of conditions. One way to test the accuracy of the computer model is to create a set of known conditions in the water system and then compare the results observed in the field against the results of the computer model simulation using the same conditions. Field testing of the system and pulling SCADA information during that time can be a profound tool for verifying data used in the hydraulic computer model and gaining greater understanding of how the water system operates.

Field testing and SCADA review can identify errors in the data for the computer model, or it may reveal an unknown condition in the field; for example, valves reported as being open might actually be closed (or vice versa), or an obstruction could be discovered in a pipeline. This can also correct erroneous model data such as incorrect pipe diameters or connections between pressure zones. Data obtained from this process can be used to determine appropriate roughness coefficients for pipe groups based on specific information about the pipes. The roughness coefficient can vary with age and pipe material, as well as by system. Therefore, these parameters were used in combination with the field testing and SCADA results to help assign appropriate friction coefficients.

6.3.1 Field Data Gathering

The field testing consisted of placing pressure loggers at various locations throughout the system. A collection of SCADA data of the system facilities during that time was downloaded. A field testing plan was developed in conjunction with CMWD staff to make efficient use of field personnel and equipment. The field data gathering plan was implemented in October 2009.

For the purpose of model calibration, 15 pressure loggers were installed in the field to record system pressures. The locations of the pressure loggers are shown on Figure 6.2 and listed in Table 6.5. The detailed approach to perform field testing and obtain SCADA data for this system is provided in the “Field Testing Plan - Carlsbad Recycled Water System” (Field Testing Plan), which is included in Appendix D. Data collected from the field testing during this time is summarized in Appendix E. This data was compared to the modeling results to determine the level of calibration.

The pressure loggers were set in place the evening of October 12, 2009 and recorded pressure 24 hours a day through the evening of October 21, 2009, when the loggers were removed and data downloaded. CMWD staff then pulled SCADA data from their system during this time. Unfortunately, a server error rendered automatic data gathering of the SCADA system inoperable for the time period. Data was manually copied by CMWD staff for the night of October 16, 2009, through the morning of October 18, 2009. Based on the available data, October 17, 2009 was then selected as the calibration day for the Extended Period Simulation (EPS) model calibration. The SCADA data pulled during this time is listed in Table 6.6.

Table 6.5 Pressure Logger Locations
Recycled Water Master Plan
Carlsbad Municipal Water District

Pressure Logger Number	Location	Pressure Zone	Comments
E6	Embarcadero Lane at Avenida Encinas	318	
3	Alicante Rd. south of Lapis Rd.	384	
E1	In front of 6827 Sand Aster Dr.	384	
E2	1440 Sapphire Dr.	384	
E5	Dahlia Way at Lowder Lane	384	
E8	Armada Dr. southwest of Legoland Dr.	384	
2	5927 Landau Ct.	384	Bad readings; removed from analysis.
X	The Crossings Dr. south of Grand Pacific Dr.	384	
XX	Wind Trail Way at Glen Ave.	384	
12	Town Garden Rd. southwest of Alicante Rd.	550	
17	Whiptail Loop and Caribou Ct.	550	
E7	Rancho Santa Fe Rd. and Avenida Soledad	550	
E4	Cay Dr. at Promontory Place	580	Hydro-pneumatic Zone
1	Rancho Bravado at Paseo Acampo	660	Hydro-pneumatic Zone
21	Lionshead Ave. at Eagle Dr.	660	Hydro-pneumatic Zone

Note: Pressure Logger Number corresponds with numbers shown on Figure 6.2.

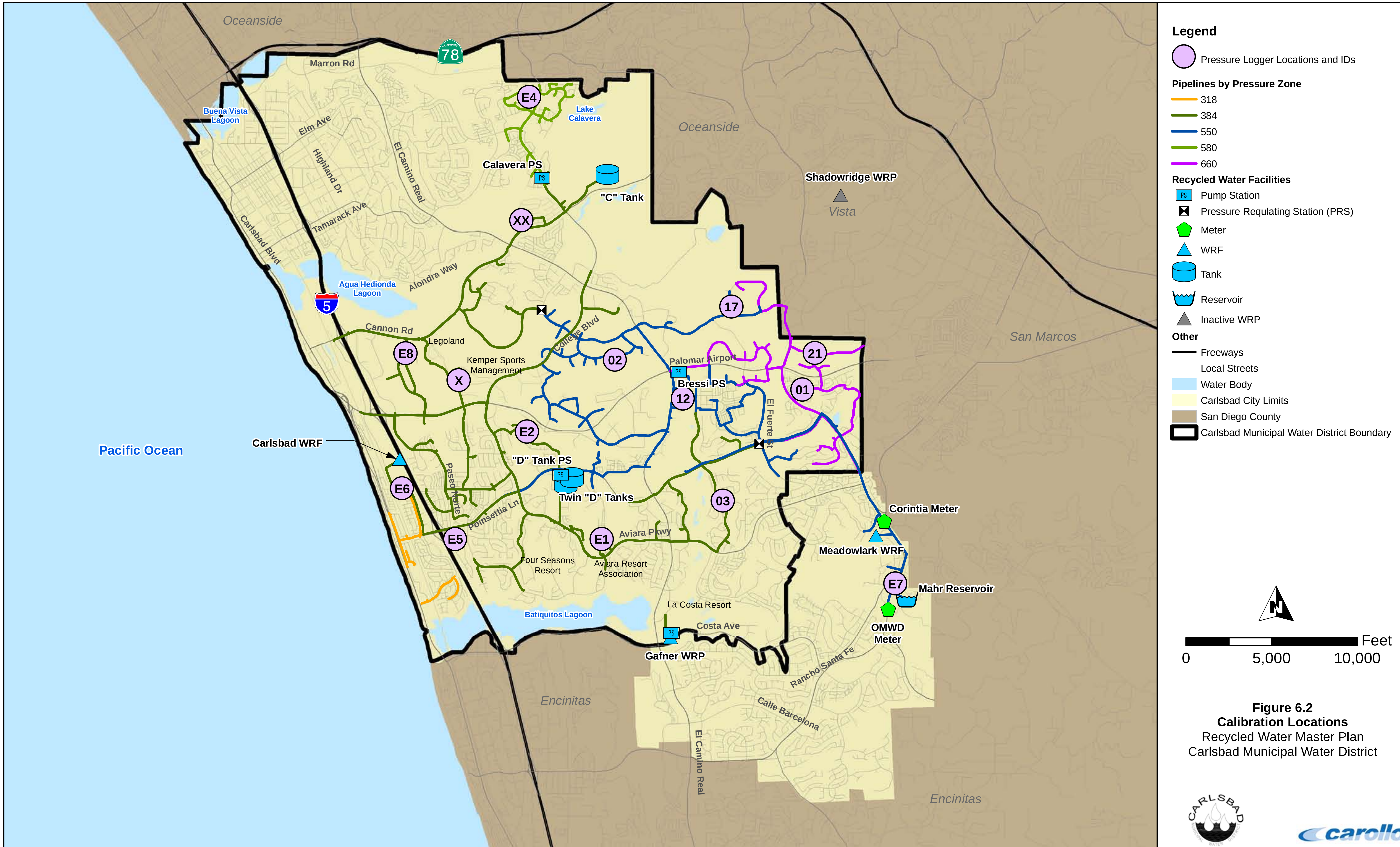


Figure 6.2
Calibration Locations
Recycled Water Master Plan
Carlsbad Municipal Water District

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Table 6.6 SCADA Data Availability
Recycled Water Master Plan
Carlsbad Municipal Water District

Facility Name	Upstream Pressure Zone	Downstream Pressure Zone	Control Details[1]
Encina/Carlsbad PS	n/a	384	
Pump 1			Closed Twin D Tank > 24-ft Open Twin D Tank < 20-ft
Pump 2			Closed
Pump 3			Closed Twin D Tank > 18-ft Open Twin D Tank < 12-ft
Twin D PS	384	550	
Pump 1			Closed
Pump 2			Closed
Pump 3			Closed
Pump 4			Closed
Bressi PS	550	660	
Pump 1			VSP – Target Pressure = 146 psi
Pump 2			Closed
Pump 3			Open if zone demand > 1,200 gpm Closed if zone demand < 700 gpm
Calavera PS[2]	384	580	
Pump 1			Open
Pump 2			Closed
Pump 3			Closed
Corintia FCV	-	550	Open
Faraday PRV	580	384	
6-inch			60 psi
10-inch			70 psi
La Costa PRV	550	384	
6-inch			102 psi – Set based on SCADA
6-inch			90 psi
8-inch			85 psi
Avenida Encinas PRV	384	318	
3-inch			109 psi – Set based on SCADA
8-inch			108 psi

Table 6.6 SCADA Data Availability (Continued)
Recycled Water Master Plan
Carlsbad Municipal Water District

Location	Upstream Pressure Zone	Downstream Pressure Zone	Control Details
Ralph Valve(3) 10-inch	550	384	55 psi – Set based on hydraulics. The Encina Basin Water Reclamation Program, Phase II Twin D Recycled Water Pump Station Plans shows that this is a 10-in combination FCV/PSV. However, CMWD staff indicate it is operated as an altitude valve.
D Tanks	384	384	Initial Level = 10.8 feet, based on SCADA
C Tank	384	384	Initial Level = 13.5 feet, based on SCADA
Mahr Reservoir	550	550	Levels set based on SCADA upstream pressures for Corintia Valve and pressure logger in area
Meadowlark Reservoir	-	550	HGL set at HWL of 318 feet. A single pump to represent two pumps. Pump Station Head with two pumps running 240 feet. Max flow of pump station with two pumps is 3,250 gpm. Based on Mahr Reservoir O&M Manual, October 2008

Note:
(1) Control details were based on operational control strategy at the time of calibration, October 2009, and are modified based on staff needs.
(2) As of Fall 2011, the Calavera Pump Station target psi was 177 psi, pump start was set for 145 psi, pump stop was set for 190 psi, and second call set for 700 gmp
(3) As of Fall 2011, the Ralph Valve is SCADA controlled by both flow total through Corinitia meter and level in D tanks.

6.3.2 Extended Period Model Calibration

One model scenario was created in the hydraulic computer model for the model calibration. The scenario was setup as an EPS run for 24 hours with demands based on actual field tank fluctuations and observed supply into the system. The goal of calibration was to have the model results within 10 percent or 5 psi of the field observations.

As described previously, the recycled water demands allocated in the model were based on the average demands obtained from the geocoded billing records of calendar year 2008. The average 2008 demand without the demands of the La Costa Golf Course demands (fed by Gafner WRP) and OMWD (fed by Meadowlark WRF) is 2,287 gpm. This demand was then scaled by 1.28 to match the total system production of 2,922 gpm recorded for October 17, 2009. The hourly supply mass balance for this day is presented in Table 6.7.

Table 6.7 Mass Balance for Calibration Day
Recycled Water Master Plan
Carlsbad Municipal Water District

Date and Time of Recordings	Supply from Carlsbad WRF PS (gpm)	Supply from Corintia Valve (gpm)	Supply from Storage Tanks C and D (gpm)	Total Supply (Demand) Balance (gpm)
10/17/09 0:00	3,352	3,571	-1,508	8,431
10/17/09 1:00	3,340	4,360	7	7,693
10/17/09 2:00	3,220	4,290	1,142	6,368
10/17/09 3:00	3,216	3,780	1,464	5,533
10/17/09 4:00	3,209	3,940	2,057	5,092
10/17/09 5:00	3,175	3,750	2,596	4,329
10/17/09 6:00	0	3,209	2,704	505
10/17/09 7:00	0	3,372	755	2,617
10/17/09 8:00	0	2,969	1,295	1,674
10/17/09 9:00	0	3,003	1,188	1,816
10/17/09 10:00	0	2,909	1,349	1,560
10/17/09 11:00	0	2,872	1,781	1,091
10/17/09 12:00	0	2,874	1,781	1,093
10/17/09 13:00	0	14	-816	830
10/17/09 14:00	0	22	-923	945
10/17/09 15:00	0	13	-923	936
10/17/09 16:00	0	11	-922	933
10/17/09 17:00	0	9	-976	985
10/17/09 18:00	0	11	-975	986
10/17/09 19:00	0	31	-1,028	1,058
10/17/09 20:00	0	559	-1,027	1,586
10/17/09 21:00	0	854	-1,945	2,799
10/17/09 22:00	3,193	1,247	-2,321	6,761
10/17/09 23:00	3,172	1,600	274	4,498
Average	**1,078**	**2,053**	**210**	**2,922**

The diurnal demand curves presented in Figure 6.3 were prepared from the supply mass balance for the two days for which SCADA data was available. It should be noted that, as SCADA data was not gathered after 1:00 p.m. for Sunday, October 18, 2009, the data from Saturday, October 17, 2009 was used for the last six hours of the weekend diurnal demand curve.

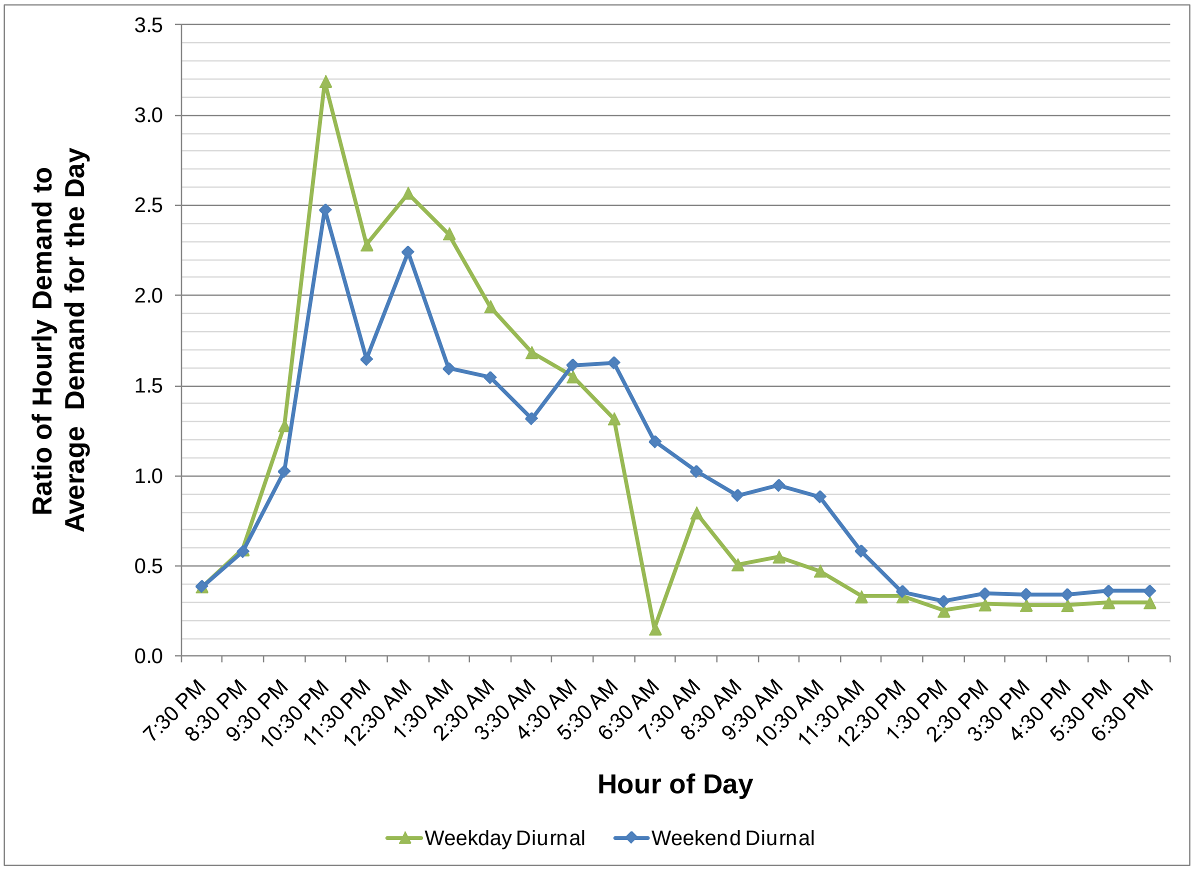

Figure 6.3 System Wide Diurnal Demand Patterns

The diurnal pattern of October 17, 2009 was then used to develop diurnal curves for individual pressure zones by adjusting for diurnal patterns that were developed for the two golf courses that take recycled water during the daytime hours to fill the on-site lakes. The diurnal curves used in the hydraulic model are smoothed out compared to the raw data shown in Figure 6.3 as the actual demand variation will vary on a daily basis and simplified curves are considered more appropriate for planning purposes.

The diurnal curves presented in Figure 6.3 indicate that CMWD's demands peak at about 11:00 p.m. and begin to drop off in the early morning hours. Demands during the day are minimal until the evening peak begins after 10:00 p.m. When compared with the typical diurnal curves presented in Chapter 3, it can be concluded that the majority of CMWD's nightly irrigation demands occur during the early night hours, between 10:00 p.m. and 3:00 a.m., and are not evenly distributed across the 8-hour irrigation period.

Hazen-Williams roughness coefficients (C factors) were assigned. These C factors were developed from standard published values for pipes of similar material and age and are presented in Table 6.8.

Table 6.8 Pipeline Roughness Coefficients
Recycled Water Master Plan
Carlsbad Municipal Water District

Class Number	Pipe Material(1)	Installation Year	Age (Years)	Percent of Total (%)	Typical C Factor Range	Selected C Factor
1	ACP	after 1970	0-35	3	130–150	130
2	CML&C STL	after 1970	0-35	15	140–150	130
3	DIP	1985 - 2004	7-26	7	130–150	130
4	PVC	All	All	75	130–160	130
5	HDPE	2000 - 2004	7-11	<1	120–150	130

Note:
(1) ACP: asbestos cement pipe
CML&C STL: cement mortar lined steel
DIP: ductile iron pipe
PVC: polyvinyl chloride

The calibration process required that the model simulations duplicate the boundary conditions observed at the time of each test. Boundary conditions include sources of supply, storage facilities, and other locations where water flows into or out of the distribution system. The boundary conditions were set based on SCADA data from the City's system during the pressure logger data retrieval.

Where significant differences were revealed between the model results and the field observations during calibration, the model data was rechecked against known data to evaluate the accuracy of the data. This could include checking pipe diameters and similar data. If this data appeared to be correct, additional steps were taken to verify connections between pipes, verify pressure zone boundaries, and perform similar checks.

Adjustments made to the model during the calibration process included:

- Establishing demand patterns / diurnal curves for users in the upper zone, lower zone, hydro-pneumatic zones, and the golf courses known to irrigate during the day. The individual demand patterns / diurnal curves were calculated such that the overall aggregate weighted demand pattern would match the mass balance calculated for the calibration period.
- Updating the hydraulic model to incorporate changes to the distribution system for which CMWD provided drawings.
- Adding hydro-pneumatic tanks to the Calavera PS and Bressi PS to better reflect how these facilities operate.

- Changing the Corintia Meter from a flow control valve to a throttle valve.
- Adding minor losses to the Corintia Meter vault and some pipelines to limit the amount of flow from Mahr and allow more pumped flow from the Carlsbad WRF.
- Revising the assumed OMWD demand pattern based on the levels in Mahr Reservoir relative to the flow through the Corintia Meter, discussions with OMWD staff, and evaluation of OMWD's 2004 Recycled Water Master Plan.
- Alterations of elevations in the vicinity of Whiptail Loop north of Faraday Avenue to reflect grading changes. During the calibration process, it was determined that grading for a development had altered the ground elevations reflected in the City's contour layer. Elevations were adjusted accordingly to reflect the grading.

The calibration process attempted to correct any errors found in the model data before calibrating friction coefficients or suggesting that unknown field conditions (such as a closed main line valve) might exist.

6.3.3 Extended Period Calibration Results

Calibration results were analyzed by comparing the differences between field observed pressures and model results for each pressure logger, pump station, and reservoir. These comparisons were made after errors were corrected and adjustments were made in the model. Charts showing the comparison of model results to field data for each logger and facility are included in Appendix F. Figure 6.4 presents the comparison of model results to field data for three storage reservoirs; D Tanks, C Tank, and Mahr Reservoir.

A shown in Figure 6.4, the levels within the reservoirs follow the trending of the field data. The model results for the pressure loggers, pump stations, and reservoirs are generally judged to fall within 10 psi of the field data.

6.3.3.1 <u>Summary of Calibration Results</u>

The locations of the remote pressure loggers that were installed in the system to gather field data are shown on Figure 6.2. The calibration results of these individual pressure loggers, as well as the tank levels, pump stations, and pressure regulating valves are presented in Appendix F.

Based on the results presented in Figure 6.4 and in Appendix F, it can be concluded that the model results closely match field conditions for most calibration points. Hence, the hydraulic model is therefore considered calibrated and can be used to evaluate the system hydraulics under existing and future demand conditions, identify deficiencies, and size facilities to address deficiencies and serve the future customers, while meeting the planning and evaluation criteria outlined in Chapter 7 of this report.

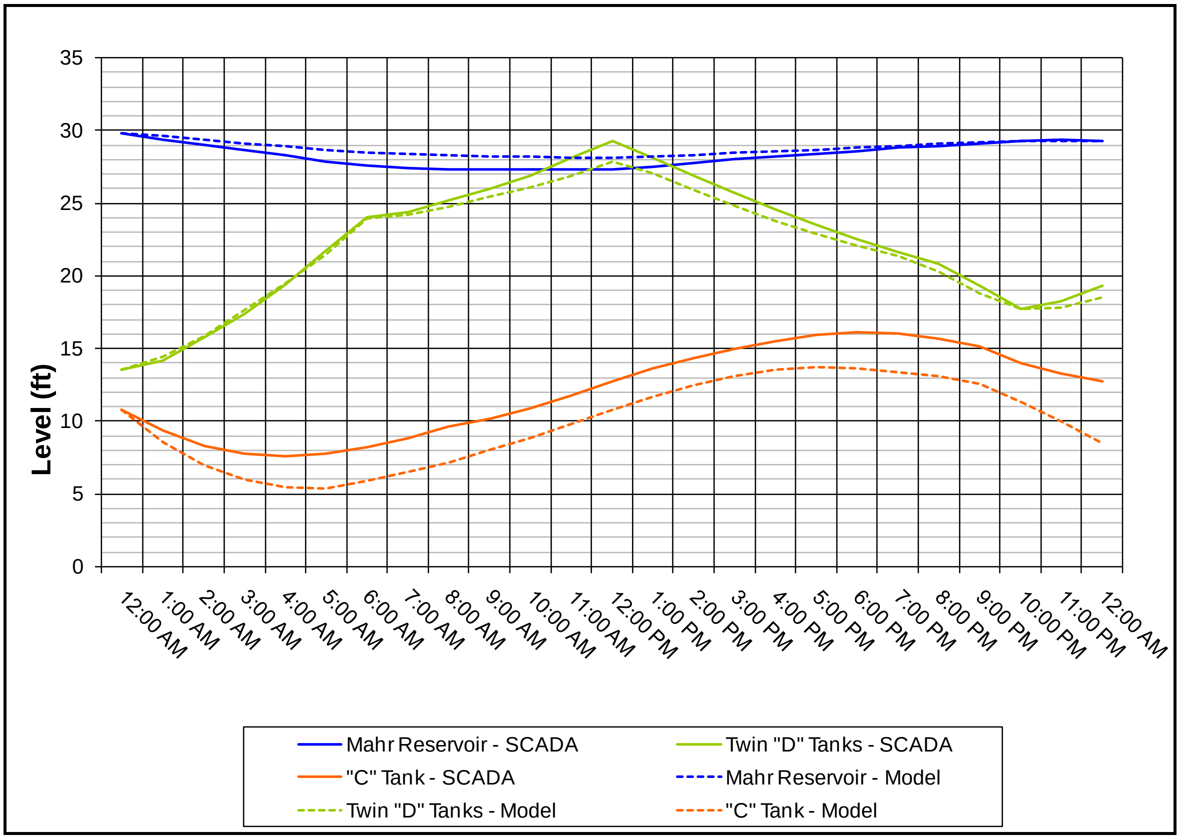

Figure 6.4 Reservoir Calibration Results

It is important to note that model calibration for any water system is an ongoing effort. As changes in the system occur from changing demands, new infrastructure development, or changing operational settings, the model must be periodically updated and checked to confirm that the model results are in agreement with field measurements. Therefore, this calibration effort serves as a baseline for future calibration efforts.

6.3.4 Water Quality Calibration

Water quality samples were obtained by CMWD staff on October 14, 2010. Initial model calibration plans (as outlined in Appendix D) were to calibrate the water quality and hydraulic components of the model over the same time period. Due to a server outage, the SCADA data was unavailable and the hydraulic calibration was conducted with data for October 17, 2009. Hence, the conditions used for the hydraulic model calibration do not coincide with the day that the water quality samples were taken.

It was necessary to make the assumption that the system operations of the recycled water distribution system are similar from day to day and that the hydraulic conditions on the day of water quality sampling (Wednesday October 14, 2009) were sufficiently similar to the day of hydraulic calibration (Saturday October 17, 2009). It should be noted that water quality modeling is extremely sensitive to the hydraulic conditions in the distribution system. The results of this water quality calibration should take this into consideration. Table 6.9 presents chlorine residual levels sampled at each of the sampling sites.

Table 6.9 Water Quality Samples
Recycled Water Master Plan
Carlsbad Municipal Water District

Sample Location ID	Location	Zone	Time(1)	Chlorine Residual (Total Chlorine mg/L)
A	Tamarack west of Cay Dr.	580	09:00	0.0
B	Transmission Main from C Tank	384	09:25	0.0
C	Cannon Rd. northeast of Faraday Av.	384	09:35	0.2
D	Faraday Av. and Priestly Dr.	550	09:47	0.2
E	Melrose Dr. between Faraday Av. and Priestly Dr.	660	10:00	5.5
F	Aviara Py., between Ambrosia Ln. and Mimosa Dr.	384	10:13	1.1
G	Corintia St. west of Melrose Dr.	N/A	10:25	3.0
H	The Crossings, south of Grand Pacific Dr. and north of Palomar Airport Rd.	384	11:37	2.0
I	Transmission Main near D Tank	384	11:09	3.0
J	Avenida Encinas and Embarcadero Ln.	384	11:25	3.9
K	Transmission Main from Mahr Reservoir	N/A	10:52	4.2

Note:
(1) All water quality samples taken on October 14, 2010.

As seen in Table 6.9, the sampled chlorine residuals ranged from 5.5 mg/L downstream of Bressi Pump Station to undetectable levels in the north areas of CMWD. The locations and levels of each of the sampled residuals are shown on Figure 6.5. Note that Sample E exceeds the sampled chlorine residual at either source (Carlsbad WRF and Meadowlark WRF), suggesting that the chlorine residual at the sources must have been fluctuating to higher levels prior to sampling (all samples were taken within a few hours).

At Carlsbad WRF, the average chlorine residual between September 15 and September 30, 2009 was 9.1 mg/L. For Meadowlark WRF, the average minimum chlorine residual during August 2009 was 16.3 mg/L. However, discussions with City staff have indicated that chlorine residual is reduced to limit the chlorine residual to less than 10 mg/L. At the time of calibration, Meadowlark WRF staff reduced the chlorine residual considerably, but without evaluating the resulting chlorine residual on a continuous basis. The modeled initial source chlorine residual was therefore adjusted iteratively to match the sampled chlorine residual of 3.0 mg/L at the location of Site G. After this iterative process, a chlorine residual of 4.5 mg/L was used at Meadowlark.

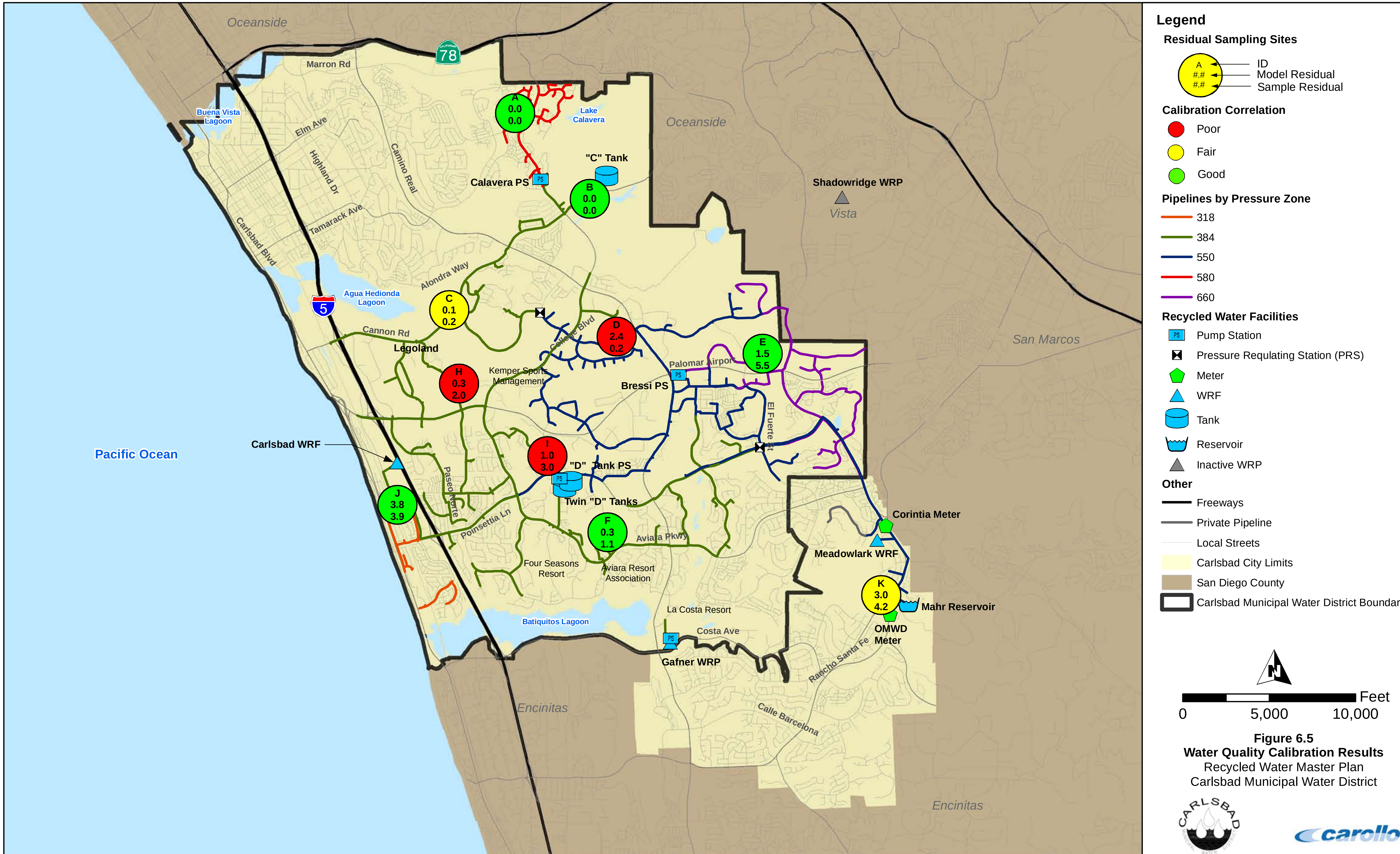

Figure 6.5
Water Quality Calibration Results
Recycled Water Master Plan
Carlsbad Municipal Water District

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While some chlorine decay information can be calculated based on the sample times and locations, detailed hydraulic information on transients within the distribution system is not available. A chlorine jar test would allow estimation of the decay coefficient by removing hydraulic variation within the system. However, a chlorine jar test data was not available. In absence of chlorine jar test data, a global bulk chlorine decay coefficient of -0.05 along with a default global wall chlorine decay coefficient of -0.15 were used.

6.3.5 Water Quality Calibration Results

Table 6.10 presents model predictions of water quality chlorine residual samples. For each model prediction, the correlation of the model predictions to the sampled chlorine residuals is noted with a qualitative statement. Good means that the model prediction and sampled chlorine residual varied by less than 10 percent. Fair means that the model prediction and sampled results varied between 10 and 50 percent. Poor means that the difference between model prediction and sampled results was greater than 50 percent.

Table 6.10 Water Quality Calibration Results
Recycled Water Master Plan
Carlsbad Municipal Water District

Sample Location ID	Pressure Zone	Sampled Chlorine Residual (Total Chlorine mg/L)	Model Predicted[1] Chlorine Residual (Total Chlorine mg/L)	Correlation of Model Prediction to Samples[2]
A	580	0.0	0.0	Good
B	384	0.0	0.0	Good
C	384	0.2	0.1	Fair
D	550	0.2	2.4	Poor
E	660	5.5	1.5	Good
F	384	1.1	0.3	Good
G	N/A	3.0	3.9	Fair
H	384	2.0	0.3	Poor
I	384	3.0	1.0	Poor
J	384	3.9	3.8	Good
K	N/A	4.2	3.0	Fair

Notes:
1) All water quality samples taken on October 14, 2010. The hydraulic model EPS calibration was conducted for October 17, 2010. Hydraulic conditions of October 17, 2010 were used for this analysis. It should be noted that water quality modeling can be extremely sensitive to the hydraulic conditions in the distribution system and the results of this water quality calibration should take this into consideration.
2) Good = Chlorine residual variance < 10 percent; Fair = 10-50 percent; and Poor = greater than 50 percent.

As shown in Table 6.10, model predictions for chlorine residual deviated significantly from the sampled chlorine residuals. The most significant deviations were in the upper pressure zones of the distribution system. Average chlorine residuals for the entire distribution system are shown by pipeline segment on Figure 6.5.

The water quality component of the model was not further calibrated. CMWD initially planned to repeat the water quality sampling. However, with the primary purpose of the model being the sizing of future pipelines, it was decided that the hydraulics of the model were accurate enough for system analysis and planning.

6.4 FUTURE SYSTEM MODEL CREATION

The future system hydraulic model was created to evaluate and size expansion alignments, pump station improvements, and storage recommendations discussed in Chapter 9. Development of the future system model consisted of the following steps:

- Determine preliminary alignments of expansion segments based on locations of the potential customers from the customer database
- Import preliminary expansion segments into the hydraulic model
- Assign demands from the customer database to the expansion segments (excluding customers too far away to be included in expansion segments, adding demands for vacant land, and remove demands from ultimate system for temporary agricultural demands)
- Increase capacity of recycled water sources, pump stations, and storage based on preliminary analysis in Chapter 9
- Increase sizing of pipelines to resolve deficiencies in the proposed system

The future system model was created based on expansion laterals to reach as many customers as possible with minimal new pipeline length. The specific alignments will be discussed in Chapter 9. Customer laterals are drawn to the customer database node within the model. However, as will be discussed in more detail in Chapters 9 and 10, costs for the customer laterals are developed based on the number of retrofit customers rather than actual pipeline length. Thus, the lengths of the customer laterals are not included in development of the expansion segment lengths.

A pipeline set was created to account for the potential decrease in friction factors as pipelines in the distribution system age. As outlined in Chapter 7, a Hazen-Williams roughness coefficient of 120 was used for pipelines over 20 years of age. For the future system, all existing pipelines were assumed to be greater than 20 years of age by this time.

Where pipeline alignments fell within the City's boundary, junction elevations were interpolated from the elevation contours provided by CMWD. For pipeline alignments outside the coverage of the elevation contours provided by CMWD, approximate elevations were calculated from data obtained from USGS (USGS, 2010).

PLANNING AND EVALUATION CRITERIA

7.1 INTRODUCTION

This chapter presents the planning and evaluation criteria that were used to identify system deficiencies in the Carlsbad Municipal Water District's (CMWD) existing system and to size system expansions. The planning and evaluation criteria discussed in this chapter include system pressures, pipelines, storage reservoirs, and booster pumping stations. The criteria discussed herein are also summarized at the end of this chapter in Table 7.1.

7.2 SYSTEM PRESSURES

The recycled water system pressure is ideally designed to be slightly lower than the potable water system pressure. This pressure differential reduces the risk of potable water contamination from recycled water, in the event that an adjacent recycled water main breaks. However, this requirement often cannot be met due to the following two reasons:

1. System pressures in water systems vary and pressure zone boundaries of potable and recycled water systems typically do not overlap.
2. It is preferred to maintain a minimum pressure in the recycled water system of approximately 60 pounds per square inch (psi) to meet the operating requirements for most sprinkler systems. However, the minimum pressure in potable water systems is typically 40 psi.

As the chance of cross contamination is minimal due to disinfection and a minimum horizontal separation of 10 feet between potable and recycled water pipelines, it is assumed that the layout of the recycled water system expansions does not need to be coordinated with the existing potable water system pressure ranges.

The minimum system pressure used for pipeline sizing in this RWMP is 60 psi under peak hour demand (PHD) conditions.

While the maximum system pressure under minimum day demand (MinDD) conditions is limited to 80 psi by the California Plumbing Code (CPC, 2007 – Section 608.2), CMWD does not anticipate dual plumbing, or other uses which would include piping inside a building. Thus, 125 psi will be used as the maximum pressure criteria, above which a pressure regulator will be considered at the meter connections. In locations with pressures exceeding 150 psi, the pipeline class used for construction of the pipeline segments should be considered.

7.3 PIPELINE VELOCITIES AND HEAD LOSS

The maximum velocity in pipelines should not exceed 7 feet per second (ft/s) under PHD conditions in all existing pipelines, regardless of diameter.

Proposed distribution pipelines, those 12 inches and less in diameter, will be sized such that the maximum velocity should not exceed 7 ft/s under PHD conditions. Proposed transmission mains, those greater than 12 inches in diameter, will be sized such that the maximum velocity should not exceed 5 ft/s under PHD conditions. A lower pipeline velocity is used for transmission mains to avoid excessive sloping of the hydraulic grade line across pressure zones.

For existing pipelines, the maximum head loss should not exceed 7 feet per thousand feet (ft/1,000 ft) under PHD conditions with the entire distribution network in service. Proposed pipelines will be sized so that the maximum head loss should not exceed 5 ft/1,000 ft.

As discussed in Chapter 6, the hydraulic model uses the Hazen-Williams hydraulic calculation to calculate head loss. A Hazen-Williams roughness coefficient of 120 is used for pipelines greater than 20 years in age, and a roughness coefficient of 130 is used for pipelines less than 20 years in age.

Most of CMWD's pipelines are relatively new and constructed of PVC material, for which a roughness coefficient of 140 is typically used in design of pipelines. The roughness coefficients used in this planning study are lower than that used in design of pipelines to account for potential biogrowth associated with recycled water systems with lower chlorine residuals, minor losses, which are not accounted for individually in this level of planning study, and other potential unknown conditions.

7.4 PIPELINE SIZING CRITERIA

Pipeline sizing is based on several factors including:

- Demand conditions
- Pipeline velocity
- Pipeline head loss

Pipelines are selected so that they do not exceed velocity and head loss criteria under PHD conditions. When a pipeline exceeds the velocity or head loss criteria during PHD, it is upsized to the next standard size. Velocity criteria are discussed above.

The minimum pipeline size of new distribution pipelines, excluding service laterals, is 4 inches in diameter, which is used for dead-end pipelines less than 1,000 feet in length. CMWD uses 6-inch pipelines for non-looped, dead-end pipelines greater than 1,000 feet in length and 8-inch diameter pipelines for looped pipelines.

The standard sizes used for pipelines include 4-inch, 6-inch, 8-inch, 12-inch, 16-inch, 20-inch, 24-inch, 30-inch, and 36-inch diameter pipelines.

7.5 STORAGE SIZING CRITERIA

To operate a recycled water system with reservoirs that are supplied from the water reclamation facilities, two types of storage are required and an additional type of storage is used within CMWD's system. These are:

1. Operational Storage. The storage required to buffer demand fluctuations under maximum day demand (MDD) conditions. The volume required for this storage component is dependent upon the hourly variation of the customer's demand and the variation of flow from the various water reclamation facilities.
2. Short-term Emergency Storage. The storage volume required to protect reservoirs from complete drainage. Emergency storage provides a few hours to respond to an emergency and make operational adjustments without immediate interruption of service.
3. Seasonal Storage. The storage volume used to buffer seasonal peak flows, allowing the system to supply customer demands in excess of the maximum daily supply capacity of CMWD's supply sources. Seasonal storage allows recycled water to be stored during periods of low demands, such as winter months, to be used during periods of high demands, such as summer months. Note that seasonal storage functions as a supply, and thus criteria for sizing seasonal storage are not applicable unless seasonal storage was sized to meet a specific supply requirement. Seasonal storage is discussed in more detail in Chapter 4.

7.5.1 Operational Storage

Operational storage is calculated based on the estimated recycled water demand of the existing customers and their associated diurnal patterns. Figure 7.1 presents an analysis based on CMWD's system diurnal curve on October 16 and 17, 2009. The average system demand in this 24-hour period was 4.9 mgd, which equates to an average demand of 3,413 gpm. Assuming demands in excess of the average demand for the day should be provided by operational storage, the area above the average demand line represents the amount of demand that must be provided from storage. This area represents approximately 1.7 million gallons (MG), which is about 33 percent of the average demand over the course of a day (1.7 MG / 4.9 mgd).

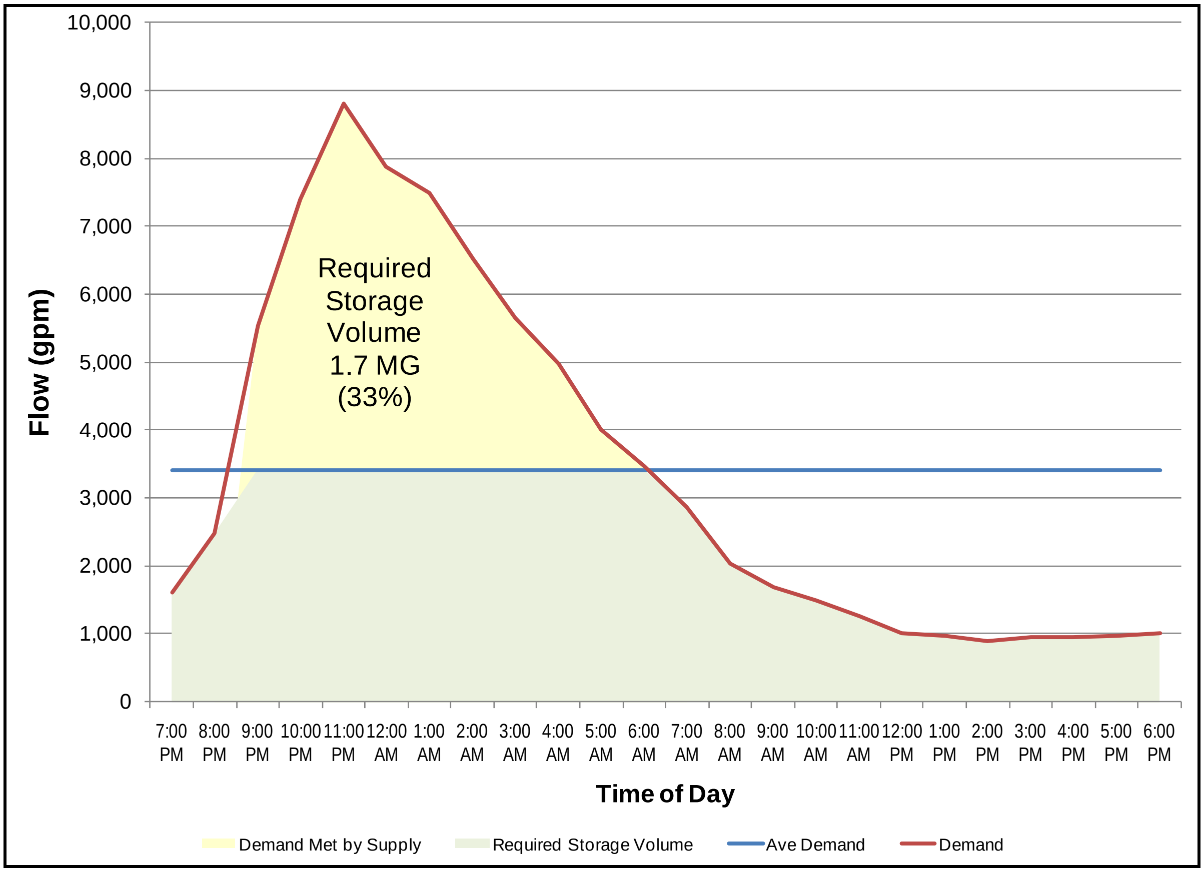

Figure 7.1 Operational Storage Requirement

CMWD's operational storage is currently provided at various locations in the recycled water distribution system and includes the following:

- C Tank
- Twin D Tanks
- Mahr Reservoir

In addition, supply from the treatment facilities is buffered by equalization basins consisting of:

- Mahr Reservoir
- Equalization basin at Carlsbad WRF

Note that Mahr Reservoir is included in both categories, as CMWD does use Mahr Reservoir for daily peaking of the 550 zone. For the purposes of this study, the supply equalization basin at Carlsbad WRF was not counted as operational storage. But functionally, CMWD can use this facility if necessary.

7.5.2 Short-term Emergency Storage

Short-term Emergency Storage is required to provide operational flexibility during emergencies, such as a temporary shutdown of any of the WRPs or pump stations. Based on an emergency response time of 4 hours, the capacity of all reservoirs should include an additional 17 percent of MDD (4 hrs / 24 hrs = 17% of MDD, which is equivalent to 80 minutes of PHD) to provide buffer capacity for emergency needs.

7.5.3 Seasonal Storage

Seasonal storage is treated as a source of supply and is discussed in more detail in Chapter 4.

7.5.4 Summary

In summary, the operational and emergency storage requirements are 33 percent of MDD and 17 percent of MDD, respectively. For planning purposes, it is therefore recommended that CMWD have a total of 50 percent (33% + 17%) of MDD available for storage.

7.6 PUMP STATION SIZING CRITERIA

Two different pump station (PS) sizing criteria were used for the system analysis in this study. The criterion that should be applied for the sizing of a PS is dependent upon the location of reservoir storage in the zone that the PS pumps into. The two criteria are:

- <u>Pressure zones with gravity reservoir storage</u>. These zones have the benefit that reservoirs provide additional supply during the peak hours of MDD (reservoir drainage) and provide buffer capacity during the minimum hours of MDD (reservoir filling). This allows pump station sizing for the average hour demand of MDD. Hence, all pump stations that pump into a zone with gravity storage are sized for MDD.
- <u>Pressure zones without gravity reservoir storage</u>. These zones do not provide the benefit of additional supply from reservoirs during the peak hours of MDD. Hence, all pump stations that pump into a zone without gravity storage (closed system) need to be sized for PHD with a standby pump unit.

The total pumping capacity of a PS needs to be sufficient to serve the required demand with the largest pump unit out of service, so that one pump unit can be designated as a spare to accommodate repairs and maintenance activities without interruption of system operations. However, this criterion was not applied to the Carlsbad WRF PS, rated at 10,000 gpm, as CMWD has incorporated storage in the pressure zone into which the Carlsbad WRF PS pumps.

7.7 SYSTEM RELIABILITY CRITERIA

System reliability criteria are intended to evaluate a recycled water system's ability to meet recycled water demands during events such as power outages. While less critical than in a potable water system, extended outages could result in costly loss of property, as irrigation may not be available for customer's landscaping, especially in the cases of customers such as golf courses, where the landscaping represents an extensive investment. As CMWD begins to connect users of different usage classes, such as industrial, dual plumbing, or fire water usage types, system reliability will be even more important.

CMWD's customers are required to maintain separation of the recycled water and potable water systems. Hence, CMWD's customers do not have potable water backup supplies with the exception of the golf courses that blend recycled water and potable water in their lakes using an air gap for the potable water supply to avoid cross connections.

In case of a power outage, the majority of CMWD's recycled water customers can be served from gravity storage and through PRV stations. The emergency storage capacity discussed in Section 7.5 provides 4 hours of supply under MDD conditions to make operational adjustments, such as the installation of a portable backup power generator.

7.8 SUMMARY PLANNING AND EVALUATION CRITERIA

The evaluation and sizing criteria described in this chapter are summarized in Table 7.1.

Table 7.1 System Evaluation Criteria
Recycled Water Master Plan
City of Carlsbad

Parameter	**Evaluation Criteria**		**Demand Condition**
System Pressure			
Minimum System Pressure	60	psi	Peak Hour Demand
Maximum System Pressure(1)	125	psi	Minimum Hour Demand
Maximum System Pressure(2)	150	psi	Minimum Hour Demand
Pipeline Velocity			
Evaluation of Existing Pipelines:			
Max. Velocity	7	ft/s	Peak Hour Demand
Sizing of New Pipelines:			
Max. Velocity (Diameter > 12-inch)	5	ft/s	Peak Hour Demand
Max. Velocity (Diameter ≤ 12-inch)	7	ft/s	Peak Hour Demand
Pipeline Head Loss			
Evaluation of existing pipelines:			
Max. Head Loss	7	ft/1,000 ft	Peak Hour Demand
Sizing of new pipelines:			
Max. Head Loss	5	ft/1,000 ft	Peak Hour Demand

Table 7.1 System Evaluation Criteria
Recycled Water Master Plan
City of Carlsbad

Friction Factor (Hazen-Williams)		
Existing Pipelines (< 20 years old)	130	All conditions
Pipelines (20-50 years old)	120	All conditions
Storage Volume		
Operational Storage	33% of MDD[(3)]	Maximum Month Demand
Short-term Emergency Storage	17% of MDD[(4)]	Maximum Month Demand
Total Storage	50% of MDD	Maximum Month Demand
Pump Station Standby Capacity		
For Zones with Gravity Storage	Meet MDD with largest pump unit OOS[(5)]	Maximum Month Demand
For Zones without Gravity Storage	Meet PHD with largest pump unit OOS[(5)]	Peak Hour Demand
Backup Power	Connection for Portable Generator (in Zones without Gravity Storage)	Peak Hour Demand

Notes:
(1) Maximum pressure without pressure reducing valves; higher pressures are acceptable if pressure reducing valves are installed at the meter connection (CPC, 2007).
(2) Maximum pressure for standard pipelines. For areas with higher pressures, the pipeline class (pressure rating) should be considered.
(3) Based on the City's diurnal pattern on October 16 - 17, 2009.
(4) Based on an emergency response time of 4 hours (4 hours divided by 24 hours).
(5) OOS = out of service

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